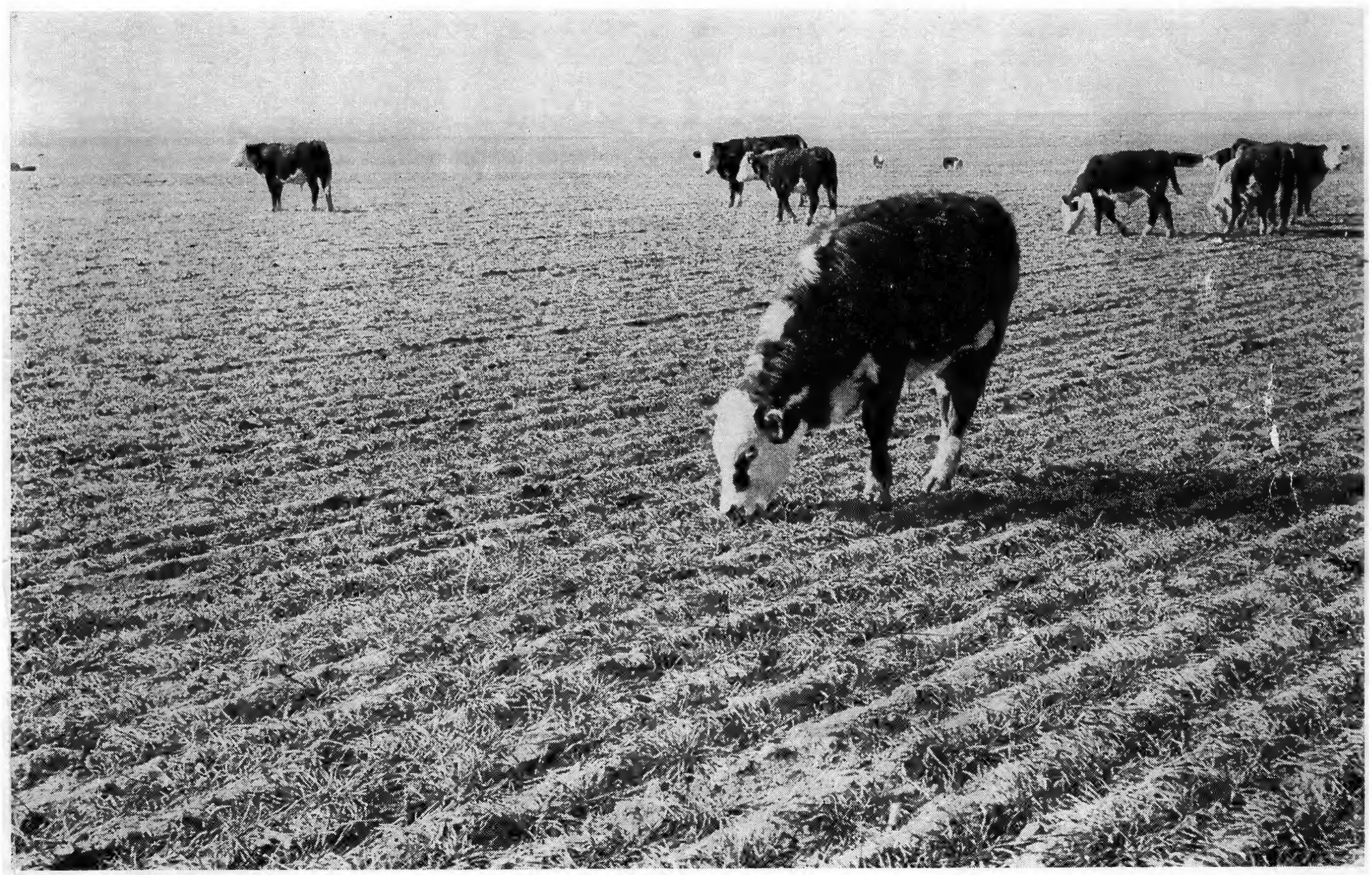
Series 1959, No. 11

Issued August 1962

SOIL SURVEY
Beaver County, Oklahoma



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
in cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY can be used as a guide in planning the management of cropland and range in Beaver County. It describes the soils, shows their location on a map, and tells what they will do if various practices are followed. It also gives information that will be helpful in planning the construction of roads, ponds, and other structures.

The soil map, found at the back of this report, is a large aerial photograph of the county. On this map you can see roads, streams, and other landmarks that will help you locate your farm.

Locating the soils

To find your land on the large map, use the index to map sheets. This is a small map of the county on which numbered rectangles have been drawn to show what part of the county each sheet of the large map covers. To locate your farm on this index map, look for roads, streams, towns, and other familiar landmarks. When you have found the map sheet for your farm, you will notice that the soils have been outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. Suppose you have found on your farm an area marked with the symbol RcA. The legend for the detailed map shows that this symbol stands for Richfield clay loam, 0 to 1 percent slopes.

Learn about the soils on your farm

Richfield clay loam, 0 to 1 percent slopes, and all other soils mapped are described in the section "Descriptions of Soils." Management for groups of soils that need about the same agricultural practices, and that respond in about the same way, is given in the subsection "Management of Capability Units." Richfield clay loam, 0 to 1 percent slopes, is in capability unit IIIc–1. Yields to be expected on this soil and other soils of the county are given in tables 2 and 3. In table 2 are yields when soils are dry-farmed, and in table 3, yields when soils are irrigated.

Make a farm plan

For the soils on your farm, compare your yields and practices with those suggested in this report. Look at your fields for signs of runoff and erosion. Then decide whether or not you need to change your methods. This survey will aid you in planning new methods, but it is not a plan of management for your farm or any other farm in the county. If you find you need help in farm planning, consult the local representative of the Soil Conservation Service. The county agricultural agent and members of your State Agricultural Experiment Station also will be glad to help you.

Finding information in this report

This report has special sections for different groups of readers, as well as sections of interest to all. A "Guide to Mapping Units" at the back of the report lists the soils in the county in alphabetic order according to map symbol and gives the pages where each soil, its capability unit, and its range site are described.

Farmers and those who work with farmers will want to refer to the section "Descriptions of Soils" to read about the soils on their farm. They can then turn to the section "Use and Management of Soils" to find how these soils can be managed and what yields can be expected.

Ranchers will find information about managing their rangeland in the section "Range Management." In this section the soils of the county are grouped in range sites, which are essentially management groups of soils used for range.

Engineers will obtain help in the section "Engineering Uses of Soils." In this section are the results of engineering tests on certain soils and an evaluation of each soil in the county for engineering work.

Soil scientists will find information about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Students, teachers, and other users can learn about the soils and their management in various parts of the report, depending on their particular interest. Those not familiar with the county may want to refer to the section "General Soil Map," which discusses broad areas of soils in the county.

* * *

Farmers and ranchers in the county organized the Beaver County Soil Conservation District in 1942. The District helps farmers and ranchers obtain technical assistance from the United States Department of Agriculture for the conservation of soil and water. This survey of the soils of Beaver County is a part of that technical help. Fieldwork was completed in 1959, and unless otherwise stated, all statements refer to conditions at that time.

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SOIL SURVEY OF BEAVER COUNTY OKLAHOMA

FIELDWORK BY FERRIS P. ALLGOOD, JACK L. BOHL, AND MAURICE O. MITCHELL, SOIL SCIENTISTS, SOIL CONSERVATION SERVICE

REPORT BY FERRIS P. ALLGOOD AND OTHERS AS INDICATED IN REPORT

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION

BEAVER COUNTY, which is in the eastern part of the Panhandle of Oklahoma (fig. 1), has an area of 1,147,520 acres. It is bounded on the north by the State of Kansas and on the south by the State of Texas. Texas County, Okla., forms its western boundary and Harper County its eastern boundary. Beaver, the county seat, is near the center of the county.

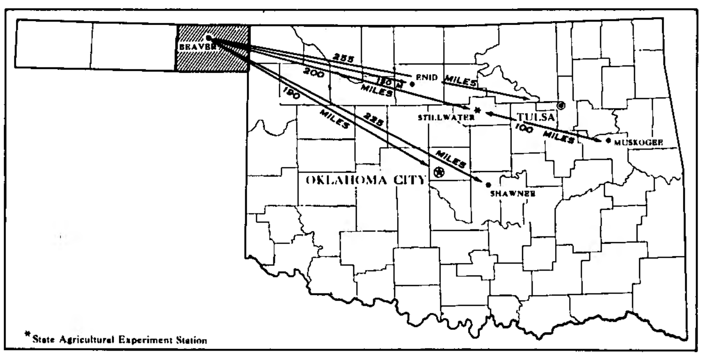

***Figure 1.*—Location of Beaver County in Oklahoma.**

Beaver County is mainly agricultural. In 1959 the acreage was about equally in crops and in pasture. Wheat is the main cash crop, and much sorghum is grown for grain, grazing, or silage. Permanent pasture is better suited than cultivated crops on much of the acreage because cropland is affected by wind and water erosion. Like other areas in the Great Plains, the county has periods of drought when crops can be produced on only the best sites. In other years, moisture is ample and yields are above average.

General Soil Map

The colored soil map at the back of this report shows the ten general patterns of soils in the county. These patterns of soils are called general soil areas, or soil associations. Each soil association consists of two or more different soils, which occur in a characteristic pattern related to the shape of the land surface and to the nature of the soil materials. (See fig. 38, p. 73.)

The general soil map is helpful to those who want a general idea of the soils, who want to compare different parts of the county, or who want to locate large areas suitable for a particular kind of agriculture or other broad land use. The map will not give enough information for the study of individual farms or for the planning of farm operations.

Soil Association 1

Deep, strongly sloping hardland: Richfield-Mansic

This soil association, or general soil area, makes up about 22 percent of the county and is the largest association in Beaver County. It is mostly in the southeastern part, in the rolling, dissected uplands below the level High Plains. Dominant in the area are the Richfield soils, which are adjacent to large areas of Mansic soils. The Richfield soils formed in a thin mantle of silty loess, whereas the Mansic soils formed in sediments of the outwash plains.

The Richfield soils are deep. Their surface soil is dark-colored, granular clay loam, and their subsoil is moderately fine textured clay loam that absorbs water slowly. The Mansic soils are less well developed than the Richfield soils and have limy material closer to the surface. They have a dark grayish-brown surface soil of clay loam and a friable, granular subsoil that absorbs water readily.

Richfield and Mansic soils are on gently sloping to moderately sloping, convex slopes and are well drained to excessively drained. This general soil area is drained by gullylike draws that have raw, limy banks and a floor of loamy alluvium.

About three-fourths of this general soil area is cultivated. The smoother, more uniform areas are in crops, and the rough, dissected areas are in range. The average-sized farm is about 1 square mile.

The native vegetation is mainly short grasses, which provide excellent grazing where management is good. Wheat is the main cultivated crop, but some grain sorghum is also grown. Because these soils are fertile, yields are good if moisture is adequate. Controlling erosion and conserving moisture are the main problems in dryland farming. In some places, erosion has severely damaged the soils. To help control erosion, farmers successfully use stubble mulching, terraces, and contour tillage.

Water for livestock is easily accessible from wells in this area, and the soil material and terrain are well suited to construction of farm ponds.

Soil Association 2

Deep and moderately deep sandy soils: Otero-Pratt

This soil association, or general soil area, makes up about 17 percent of the county It is rolling, dissected rangeland in northern Beaver County. Dominant in the area are the Otero and Pratt soils, which occur in a mixed and complex pattern.

The surface soil in the area ranges in texture from loam to sand, and the subsoil, from sand to clay. In small strips there are shallow soils that have caliche on or near the surface. Parts of the landscape are rugged and are dissected by the steep breaks and sand-choked draws that drain the area. Relief varies from smooth and nearly level to hilly and steep.

The Otero soils formed in sediments from the outwash plains that were deposited by water during the Tertiary geological period, whereas the Pratt soils formed in wind-deposited sand. Otero soils, the most extensive in the area, occupy the more uniform and the rugged parts of the general soil area. Intermingled with them are the Pratt soils, which are on low dunes or on undulating terrain.

The Otero soils have a brown to light-brown surface soil of fine sandy loam and a sandy subsoil that is loose and limy. These soils soak up water rapidly but lack the ability to hold and store moisture. The Pratt soils contain little lime, and their subsoil is more loamy than that of the Otero soils. Short grasses thrive more easily on the Otero soils than on the Pratt soils; tall grasses are better suited to the Pratt soils.

Several ranches in this general soil area contain thousands of acres, but most of the acreage is too sandy and too steep for cultivation. Livestock is more profitable than crops because the soils are well suited to range. When well managed, these soils produce some of the highest forage yields in the county. Also, in winter, the rugged terrain provides grazing and protection for livestock.

Management of grazing and control of erosion are the main problems in the area. Heavily grazed pastures are infested by sand sagebrush. Most ranchers have small acreages well suited to feed crops, and some of the shallow soils in nearly level spots have been cleared for cultivation. The shallow soils, however, generally have been farmed so intensively that erosion has damaged them. Yields have decreased, and some of the acreages are now idle. To prevent further loss of soil and to maintain productivity, some eroded fields have been reseeded to native grass.

Soil Association 3

Deep, strongly sloping loamy soils: Mansic-Woodward-Carey

This soil association, or general soil area, is mostly on the long slopes south of the Beaver River. Small acreages are on the northern bank of the Beaver River and along the Cimarron River. This area, which consists mainly of moderately deep and deep, loamy soils, makes up about 12 percent of the county.

This general soil area contains about 40 percent Mansic soils, 20 percent Woodward soils, and 30 percent Carey soils. The remaining 10 percent is made up of Vernon and other soils. The Vernon soils are mainly on the western border of the county. The Carey, Woodward, and Vernon soils formed in material weathered from the Permian red beds. The Mansic soils formed in a thin mantle of outwash sediments deposited on the red beds. The Mansic and the Woodward soils occur between the Tertiary outwash and the exposed Permian red beds. The pattern of these soils is mixed.

The Mansic and Woodward soils are friable and are moderate in permeability and in capacity to store water. The Woodward soils have a brown to dark-brown loam surface soil and a reddish subsoil. The Mansic soils are less red than the Woodward soils and contain more clay. The Carey soils have a dark-colored, silty surface soil. Their subsoil is very friable and permeable, but it contains more clay than does the surface layer. Generally these soils are redder as depth increases.

The soils of this general soil area range from smooth and nearly level to moderately sloping. On the upper slopes are the Mansic and Woodward soils. The deep Carey soils are on the smooth, nearly level or gently sloping divides. In some places, erosion has removed much of the more recently deposited soil material and the red beds are exposed or are near the surface. In places the land is broken by gullylike drainageways that have raw, red banks and a floor of loamy alluvium. Along these erosional areas are the shallow, reddish-colored Vernon soils.

About two-thirds of this general soil area is cultivated. Wheat is the main crop, but small acreages are planted to sorghum. The steep, rough areas are in range. The average-sized farm is about 900 acres. The Carey soils are suited to irrigation in their more level parts, but only small fields are irrigated. Erosion and the conservation of moisture are the main problems in cultivating the soils in this general soil area. Dryland farming in sloping areas needs intensive management if these soils are to remain productive. In places, wind and water erosion have already damaged the soils.

Well water in this soil area generally contains too much gypsum for livestock. The terrain and soil material, however, are excellent for construction of farm ponds, and in many of the drainageways, adequate farm ponds can be constructed to provide water for livestock during dry periods.

Soil Association 4

Deep, moderately sloping loamy soils: Ulysses-Richfield

This soil association, or general soil area, contains hardland soils and makes up about 8 percent of the county. It is mostly on the broad ridges and slopes of drainageways on the upland plains in the southern part of Beaver County. A small part consists of a strip of tableland near Knowles and Gate, on the divide between the Beaver and Cimarron Rivers. Both rivers drain this land. The general soil area surrounds the Richfield and Pullman soils in the south and borders the Mansker and Potter soils on the caliche rims of the High Plains to the north.

Dominant in this association are the Ulysses and Richfield soils. The Ulysses soils, which are the more extensive, occur mainly on smooth, convex slopes adjacent to

the drainageways of the High Plains. The Richfield soils are on the more level areas on the divides. The Ulysses soils are gently sloping to moderately sloping, whereas the Richfield soils are nearly level to gently sloping.

The soils in this general soil area formed in silty, wind-deposited material. Ulysses soils contain much lime and have an ashy silt loam surface soil above a friable silty clay loam subsoil that absorbs water readily. The Richfield soils are darker than the Ulysses and are deeper to the lime. Their surface layer is friable clay loam, and their subsoil, a fairly compact clay loam that absorbs water slowly.

Drainage is generally good in this soil area. Though it is slow in nearly level parts, it is moderately rapid in the sloping parts. Conserving moisture and controlling erosion are the main problems in dryland farming. Erosion is a constant problem on the sloping soils. Stubble mulching, contour tillage, and terraces are effective in controlling erosion.

The average-sized farm is about 1 square mile. General farming is practiced, and about 80 percent of the association is cropland. Generally, the more nearly level soils are in cultivated crops, and the rolling, dissected areas are in pasture. The principal crop is wheat, but in places where the wheat fails to grow, grain sorghum is planted with fair success. The native vegetation is mostly short grasses. Forage yields are high if moisture is adequate, but pasture can be easily damaged by overgrazing when moisture is scarce. In dry seasons, farmers need a good supply of feed for livestock.

Farm ponds have been constructed in many draws that drain the area, and many provide adequate water for livestock in dry periods. Wells are a fairly dependable source of water, and many of them are equipped with windmills.

Soil Association 5

Deep sandy soils and sandhills: Dalhart-Pratt

This soil association, or general soil area, is on the gently rolling, sandy plains, in the north-central and extreme northwestern parts of Beaver County. This area consists mainly of the deep Dalhart and Pratt soils and makes up about 8 percent of the county. The Dalhart soils are dominant. They are smooth and nearly level to gently undulating, whereas the Pratt soils are gently undulating to steeply undulating. The Pratt soils occur between the Dalhart soils and the sandier and more sloping Pratt-Tivoli soils.

The soils in this soil area formed in wind-deposited sand. The Dalhart soils have a brown to dark yellowish-brown surface soil and a sandy clay loam subsoil. They are friable and granular and are moderate to high in permeability and in capacity to store water. Water from the Dalhart soils drains through shallow, sandy drainageways to large streams or is caught in playa lakes.

Pratt soils have a sandier subsoil than that in the Dalhart soils. Their surface soil is brown or dark-brown fine sandy loam, and their subsoil, slightly sticky fine sandy loam. These soils absorb water rapidly but dry out more readily than the Dalhart soils. Little water runs off of the sandy Pratt soils, unless rainfall is intensive. Most runoff is trapped in narrow depressions that form a network throughout the soil area.

The average-sized farm in this general soil area is about 480 acres, and about 80 percent of the area is in crops. The soils are well suited to row crops because their capacity to hold water is high. Where stubble-mulch tillage is practiced, wheat and other small grains produce good yields. The more nearly level Dalhart soils are well suited to irrigation, but at present only a few small areas are irrigated.

A severe hazard of wind erosion is the main problem in cultivating the soils. The native vegetation is tall grasses. Many pastures, however, have been heavily grazed, and the short grasses have increased. Also, sand sagebrush has infested many of the pastures. If the soils are left bare or are improperly managed, they blow severely. Wells equipped with windmills are the main source of water for livestock.

Soil Association 6

Gently sloping limy soils: Otero-Mansker

This soil association, or general soil area, occupies gently sloping, dissected rangeland that is moderately sandy and loamy. It makes up about 8 percent of the county and is in one broad area in the southeastern part of Beaver County. Dominant in the area are Otero and Mansker soils in a mixed and complex pattern. These soils formed in water-deposited sediments of calcareous sand and loam. The terrain is gently undulating to undulating and is interrupted in places by steep breaks and sand-choked drainageways.

Most extensive in the area are the Otero soils. These soils have a brown fine sandy loam surface soil and a strongly calcareous, loose, sandy subsoil. Water soaks into these soils rapidly, but they lack the ability to hold and store much moisture. If their native vegetation is removed, the soils are droughty and highly susceptible to erosion. The Mansker soils are less sandy than the Otero soils and have distinct accumulations of lime or caliche in their subsoil. Their surface soil is brown to grayish brown and loamy. Permeability is moderate in the upper layers but slow in the limy layer.

The soils in this association are well drained to excessively drained. The native vegetation consists of short and tall grasses mixed with scattered sand sagebrush. If management is good, fair to good yields of forage are produced. In winter, the rough breaks and draws in the area provide grazing and protection for livestock.

Where slopes in this general soil area are not too steep, some of the shallow soils have been used for crops. It is difficult to maintain productivity, however, because these soils are easily damaged by erosion. Many areas were farmed for a few years, but yields decreased and the fields were left idle or were reseeded to grass. Most ranches in the area are large and have small acreages in range that are suitable for producing reserve and supplemental feed.

Management of grazing and control of erosion are the main agricultural problems in this area. Wells equipped with windmills provide most of the water for livestock. In dry periods, the water in ponds is generally adequate. Constructing these ponds is difficult, however, because the

soil material along drainageways is sandy and stable sites are few.

Soil Association 7

Deep, nearly level hardland: Richfield-Pullman

This soil association, or general soil area, consists of deep, dark soils in the southern part of the High Plains. The soils are commonly called hardlands. This soil association makes up about 7 percent of the county and occupies the broad, smooth upland plains in southern Beaver County. The area is smooth and nearly level to gently sloping and is drained by playa lakes or indistinct drainageways scattered through the area. On the floor of these lakes are the Randall soils. In places, treeless draws bordered by Ulysses soils break the level terrain. The soils in this general soil area formed in silty, wind-deposited material. Richfield soils, which are dominant in the area, occupy a belt that is between a large area of Pullman soils to the south and the more sloping Ulysses soils to the north.

In some places entire farms consist of the Richfield soils. These soils are mostly smooth and nearly level, but small areas are gently sloping. Their surface soil is dark-brown or dark grayish-brown clay loam, and their subsoil is moderately compact and contains more clay than the surface soil. Water permeates these soils slowly, but their water-holding capacity is fairly high. The Pullman soils are in broad areas along the Oklahoma-Texas line in southern Beaver County. These nearly level soils are more clayey and compact than the Richfield soils, and their subsoil is less permeable.

The average-sized farm in this general soil area is about 480 acres. Nearly all of the acreage is in crops; a few small areas are in pasture. The soils are deep, fertile, and among the best in the county for wheat. When moisture is adequate, yields of wheat and grain sorghum are high. The more nearly level soils in the area respond well to irrigation, and some of the best wells used for irrigation are located in this area.

The native vegetation is mainly short grasses. Pastures are generally small and in many places are heavily grazed. Some of them contain playa lakes. Conserving moisture and controlling erosion are the principal problems in farming these soils, especially in the more sloping areas.

Because most of this general soil area is nearly level, natural sites for farm ponds are scarce. Wells equipped with windmills provide most of the water for livestock.

Soil Association 8

Deep, nearly level loamy soils: Dalhart-Richfield

This soil association, or general soil area, which makes up about 7 percent of the county, is on smooth uplands in the northwestern part of Beaver County. It is south of the Dalhart-Pratt soil association and 2 to 4 miles north of the Beaver River. The soils in this area formed in loamy and sandy, wind-deposited material. Dominant in the area are the deep, sandy Dalhart soils on smooth, nearly level to gently undulating slopes. These soils have a brown to yellowish-brown fine sandy loam surface soil and a friable, granular sandy clay loam subsoil that absorbs water readily.

The Richfield soils in this soil area are less permeable than the Dalhart, but their water-holding capacity is fairly high. The Richfield soils are deep, dark, hardland soils that have a dark-brown or dark grayish-brown loam surface soil and a moderately tight clay loam subsoil that absorbs water slowly. They are on smooth, nearly level slopes.

Small areas of Pratt, Randall, and Ulysses soils are included with the Dalhart and Richfield in this general soil area. The soils are well drained. Runoff is ordinarily slow, except when rains are heavy; it drains into playa lakes or through shallow, sandy draws into the Beaver River.

The average-sized farm in this general soil area is about 1 square mile. Nearly all of the soils are in crops. The Dalhart soils are well suited to grain sorghum and other row crops because moisture relations are good. Where stubble mulched, wheat yields are also good. The nearly level Richfield soils are planted mainly to wheat. They are well suited to irrigation, but only a small acreage is now irrigated.

Wind erosion and the conserving of moisture are the main problems in cultivating these soils. The Dalhart soils are especially erodible, and the Richfield and more sloping Dalhart soils are droughty unless moisture is conserved.

Though farmers in this general soil area raise few cattle, small pastures of native grass are commonly overgrazed. Deep wells provide most of the water for livestock and domestic use.

Soil Association 9

Sand dunes: Tivoli-Pratt-Likes

This soil association, or general soil area, makes up about 7 percent of the county and occupies sandhills on the northern bank of the Beaver River. It averages about 2 miles in width and follows the river throughout its course in Beaver County. The steeper dunes, consisting of Tivoli soils, are from 20 to 60 feet high and adjoin the riverbank. The lower dunes, consisting of a complex of Pratt and Tivoli soils, are farther from the stream. On the gently sloping to moderately sloping, concave foot slopes are the calcareous Likes soils. These soils formed in colluvial and alluvial material washed from higher lying soils and from wind-deposited sand.

Dominant in this soil area are weakly developed, young Tivoli soils. Their surface soil is brown, loose fine sand that is highly erodible and that blows severely if the natural vegetative cover is thinned or removed. Their subsoil is yellowish-brown, loose, wind-sifted sand that absorbs water rapidly but has a low moisture-holding capacity.

In some places the Tivoli soils occur in a complex with the more stable Pratt soils. The Pratt soils have a grayish-brown loamy fine sand surface soil and a yellowish-brown loamy fine sand subsoil that soaks up water rapidly. The Likes soils are less sloping and more stable than the Pratt or Tivoli soils. They have a surface soil of dark-brown loamy fine sand and a subsoil of loose, calcareous

loamy fine sand that soaks up water rapidly but has a low moisture-holding capacity.

Unless rains are heavy, runoff is almost negligible in this general soil area. Most of the water soaks into the soils or is caught in narrow depressions before it reaches the drainageways. In the depressions the soils are deeper, darker, and contain more clay than those of the surrounding areas.

Parts of a number of large ranches along the river are in this soil association. The soils in these parts are not suited to cultivation; nearly all of them are in range. A good vegetative cover is needed because the soils blow severely if the native vegetation has been removed or is sparse. Blowouts on Tivoli fine sand spread rapidly into large areas of active dunes, and on steep sandhills active dunes are common. Areas of active dunes are generally from 30 to 100 acres in size, but some are as large as 600 acres. Areas of the Pratt-Tivoli complex of loamy fine sands are more stable than the areas of Tivoli soils mapped separately, and they require less intensive management. Areas of the complex, however, will also erode severely if vegetation is removed.

Where grazing is well managed, yields of forage are good. The narrow depressions scattered throughout the Tivoli soils provide good grazing and protection for livestock in winter. A few trees in these depressions protect livestock and wildlife.

The vegetation on Tivoli fine sand is mostly tall grasses, sand sagebrush, and skunkbush. On Pratt-Tivoli loamy fine sands are mid and tall grasses and sand sagebrush, which increases with heavy grazing. Under good management, the Likes soils provide excellent forage for livestock. The native vegetation on these soils consists mostly of tall grasses, but sand sagebrush has invaded many places that have been grazed heavily.

Soil Association 10

Deep soils on bottom lands: Las Animas-Lincoln-Spur-Canadian

This soil association, or general soil area, consists of alluvial lands on the flood plains of major creeks and rivers in Beaver County. The area consists mainly of Las Animas, Lincoln, Spur, and Canadian soils and makes up about 4 percent of the county.

The Las Animas soils are poorly drained and occur on nearly level flood plains adjacent to stream channels. Large areas adjoin the streambeds of the Beaver and Cimarron Rivers in places that are occasionally flooded, mostly by backwater. Flooding normally causes little damage, except where the stream channel changes its course and cuts through vegetated areas. The Las Animas soils have a loamy surface soil and a waterlogged, sandy subsoil.

The Lincoln soils are sandy and are less fertile than the Las Animas soils. Because they are closer to streams, the Las Animas and Lincoln soils receive soil material washed from the upland plains during floods. Shifting stream channels sometimes damage these soils.

The Spur and Canadian soils are normally farther from the stream channels than the Lincoln soils and are flooded only occasionally. At times, soil material washes down from higher areas. The Spur and Canadian soils are nearly level. The Spur soils are deep, dark, and loamy and formed in silty outwash sediments. The Canadian soils are deep, fertile, and more sandy than the Spur soils and are more susceptible to wind erosion.

The poorly drained Las Animas soils and the sandy Lincoln soils are not suited to cultivation but are well suited to range. The Las Animas soils are especially well suited to this use. They produce large and dependable yields of forage and, in many places, are used as meadow. The Lincoln soils are less productive than the Las Animas soils but provide fair grazing under good management.

The Spur and Canadian soils are mostly planted to crops. They are fertile, well drained, and fairly easy to manage. When moisture conditions are favorable, yields of wheat are excellent. If these soils are irrigated, they produce large yields of alfalfa. Erosion and lack of moisture are the main problems of management.

How a Soil Survey is Made

The scientist who makes a soil survey examines the soils in the field, classifies them in accordance with the facts that he observes, and maps their boundaries on an aerial photograph.

Field study: The soil scientist walks or drives over the county and digs or bores many holes to see what the soils are like. He also observes exposed soils in road cuts and other excavations. Each hole or road cut reveals several distinct layers, called horizons, which collectively are known as the soil profile. Each layer is studied to see how it differs from others in the profile and to learn things about the soil that influence plant growth. The scientist observes the kinds of crops or wild plants and their habits of growth. He also talks with farmers about yields and about management practices.

Descriptions of the soils are written from the information recorded during the survey. In describing the soils, the scientist uses some technical terms. When he writes of *texture*, he is referring to the relative amounts of sand, silt, and clay that make up the soil. A loamy sand contains mostly particles of sand and smaller proportions of the finer particles, silt and clay. A clay contains enough fine material to make the soil plastic and sticky. Most other textures are between sand and clay.

Structure refers to the arrangement of the soil grains into lumps, granules, or other aggregates and the arrangement of these aggregates among themselves. We need to know three things about the structure of the aggregates—their strength or distinctness, their size, and their shape. Soils without definite structure are described as *single grain* if they are sand, or as *massive* if they are clay. The ease or difficulty with which a soil is penetrated by plant roots and by moisture is determined to a large degree by structure.

Color, which is noted in each layer, is an indication of the content of organic matter. The darker the surface layer, as a rule, the more organic matter it contains. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration.

Consistence, which is the tendency of a soil to crumble or to stick together, indicates whether the soil is difficult to keep open and porous under cultivation. Consistence also indicates the resistance of a soil to erosion.

Other characteristics observed in the course of field study and considered in classifying the soil include the depth to unweathered parent material, the steepness of slope, the degree of erosion, the nature of the parent material from which it formed, and the acidity or alkalinity as measured by chemical tests.

CLASSIFICATION: On the basis of characteristics observed by the field survey team or determined by laboratory tests, soils are classified into phases, types, and series. The soil type, which may consist of several phases, is the basic classification unit. Types that resemble each other in most characteristics are grouped in soil series.

A *soil series* generally consists of two or more soil types that differ in texture of the surface soil but that are otherwise similar in kind, thickness, and arrangement of layers. In a given area, however, a soil series may be represented by only one soil type. Each series is named for a place near which it was first mapped.

A *soil type* consists of soils that are similar in kind, thickness, and arrangement of soil layers.

A *soil phase* is a subdivision of a soil type that is made because of differences other than those of kind, thickness, and arrangement of layers. Variations in slope, frequency of rock outcrops, degree of erosion, depth of soil over the substratum, or natural drainage are examples of characteristics that suggest dividing a soil type into phases.

A soil phase (or a soil type if it has not been subdivided) is the unit shown on the soil map. It is the unit that has the narrowest range of characteristics. Use and management practices, therefore, can be specified more easily for the soil phase than for soil series or yet broader groups that contain more variations.

A *miscellaneous land type* is a mapping unit that, because it has little soil or for some other reason, cannot feasibly be classified as a soil. These units are given descriptive names. In Beaver County, Active dunes was so classified because it contains little true soil. Alluvial and broken land was so classified because it lacks uniformity.

A *soil complex* consists of two or more soils that are mapped together as one unit because they are so intermingled that it is not practical to show each soil separately on a soil map.

Other agricultural terms used in describing the soils of Beaver County are defined in the Glossary.

Descriptions of Soils

This section provides information about the soils of Beaver County. It describes the soil series, or groups of soils that are essentially the same in kind of parent material and other characteristics, and the single soils, or mapping units, that are shown on the detailed map at the back of this report.

The soil series are arranged in alphabetic order. Each series, including a profile that is representative of the series, is described. Following each series are descriptions of the single soils, or mapping units, in that series. A mapping unit is one or more areas on the ground, identified by a symbol on the soil map. Normally, a mapping unit is a member of a soil series, but it may also be two or more soils in areas too small to separate on the map (soil complex); or several soils recognized as different but, for practical reasons of management, not enough different to be separated (undifferentiated soil group); or areas of alluvial land, sand dunes, and the like, that cannot be called soil, because they possess few or none of the characteristics we think of when we speak of soil.

In most instances, however, a mapping unit is a member of a soil series and is either a soil type or a soil phase. Nevertheless, in Beaver County more than a normal number of units contain more than one soil and are mapped as soil complexes.

In the profile descriptions, some terms are used that may not be familiar. The upper part of the soil is called the *A horizon*. This term refers to the layer that has lost some of its clay and other soluble minerals. Water has leached these out and carried them to the horizon below. The A horizon may be divided into A_1, A_2, and A_3 horizons.

The *B horizon* is the layer or layers in which clays and minerals leached from the A horizon have accumulated. This horizon is sometimes divided into B_1, B_2, and B_3 horizons. It is frequently referred to as *subsoil*.

Below the B horizon is the *C horizon*, or parent material. This is the unconsolidated mass of rock or other material from which the soil develops.

The color of a soil horizon is denoted by words such as "yellowish brown," and by Munsell notations such as "10YR 5/6." Munsell notations indicate color more precisely than words and are used mainly by soil scientists and others who must make detailed comparisons of soils. In this report, the color denoted by words, and by the Munsell notations that follow, is generally given first for dry soil and then for moist soil.

Other terms, such as texture, structure, and consistence, as well as methods of mapping soils, are described in the section "How a Soil Survey is Made." Soil terms are also given in the Glossary. The approximate acreage and the proportionate extent of soils are given in table 1.

Active Dunes

This land type consists of wind-sifted sands that are free to shift and blow with the wind.

Active dunes (Ac) in Beaver County are in areas larger than 20 acres. They are surrounded by Tivoli soils. The largest areas of Active dunes range from 500 to 600 acres in size, but the most common size is about 50 acres. Some of these dunes have become active in recent years, and others have been rolling and shifting for many years. Where livestock has grazed and trampled continuously, blowouts are common because there is not enough vegetation to hold the soil in place. Small blowouts grow quickly into active dunes, especially in overgrazed areas. If blowouts do start, take the cattle off the land. The best way to prevent Active dunes from forming is to maintain a good cover of grass. Active dunes may be reclaimed by planting a suitable grass when moisture is adequate. (Capability unit VIII-1; no range site)

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Area	Extent
	Acres	*Percent*
Active dunes	2, 215	0. 2
Alluvial and broken land	13, 719	1. 2
Bippus clay loam, 1 to 3 percent slopes	15, 249	1. 3
Canadian fine sandy loam	6, 442	. 6
Carey silt loam, 0 to 1 percent slopes	2, 097	. 2
Carey silt loam, 1 to 3 percent slopes	15, 097	1. 3
Dalhart fine sandy loam, 0 to 1 percent slopes	38, 076	3. 3
Dalhart fine sandy loam, 1 to 3 percent slopes	42, 588	3. 7
Las Animas soils	30, 547	2. 7
Likes loamy fine sand	13, 957	1. 2
Lincoln soils	19, 452	1. 7
Mansic clay loam, 1 to 3 percent slopes	7, 335	. 6
Mansic clay loam, 3 to 5 percent slopes, eroded	59, 597	5. 2
Mansic soils, severely eroded	25, 447	2. 2
Mansic-Otero complex, 1 to 3 percent slopes	22, 754	2. 0
Mansic-Woodward complex, 1 to 3 percent slopes	19, 002	1. 7
Mansic-Woodward complex, 3 to 5 percent slopes, eroded	39, 122	3. 4
Mansker clay loam, 1 to 3 percent slopes	2, 481	. 2
Mansker clay loam, 3 to 5 percent slopes	6, 913	. 6
Mansker-Potter complex	69, 855	6. 1
Otero soils, 3 to 5 percent slopes, eroded	22, 850	2. 0
Otero-Mansker complex	75, 082	6. 5
Otero-Pratt fine sandy loams, 3 to 12 percent slopes	88, 449	7. 7
Pratt fine sandy loam, undulating	28, 961	2. 5
Pratt loamy fine sand	21, 156	1. 9
Pratt-Tivoli loamy fine sands	56, 412	4. 9
Pullman clay loam	6, 913	. 6
Randall clay	2, 822	. 3
Richfield clay loam, 0 to 1 percent slopes	43, 197	3. 8
Richfield clay loam, 1 to 3 percent slopes	45, 204	3. 9
Richfield-Mansic clay loams, 3 to 5 percent slopes	50, 421	4. 4
Richfield loam, thick surface	45, 047	3. 9
Spur soils	8, 388	. 7
Tivoli fine sand	38, 520	3. 4
Ulysses silt loam, 0 to 1 percent slopes	2, 423	. 2
Ulysses silt loam, 1 to 3 percent slopes	28, 072	2. 5
Ulysses silt loam, 3 to 5 percent slopes	40, 233	3. 5
Ulysses-Richfield complex	41, 797	3. 6
Vernon loams	2, 654	. 2
Woodward-Mansic complex	33, 089	2. 9
Water	13, 885	1. 2
Total	1, 147, 520	100. 0

Alluvial and Broken Land

This land type consists of intermingling bodies of soils that are cut by gullylike drainageways. These drainageways are in a zigzag pattern and have abrupt banks. Overfalls sometimes occur.

Alluvial and broken land (Ar) is part of the drainage pattern on the rolling uplands in the south-central and eastern parts of Beaver County. Many areas of the Mansic and Richfield soils and smaller areas of the Woodward, Vernon, and Carey soils are drained by the drainageways that make up part of this land type. Broken areas of those soils are adjacent to the drainageways, and the raw banks of the drains generally expose their profiles. Below the narrow banks are concave floors of colluvial and alluvial material. Here, the soil material is similar to that of the Bippus, Mansic, and Spur soils, and some is sandy enough to be Lincoln soils.

Areas of this mapping unit range from 25 to 500 feet wide and from several hundred feet to more than a mile long. The amounts of the different kinds of soils in Alluvial and broken land vary considerably from place to place, according to the kinds of surrounding soils. Where mapped near the Mansic and the Richfield soils, those soils are generally dominant in this land type. Where mapped near the Woodward, Mansic, and Vernon soils, those soils are normally the main soils.

Soils similar to the surrounding soils generally make up 60 percent of this mapping unit; soils on the concave floor of the drainageways make up about 30 percent; and raw, limy banks make up about 10 percent. In nearly all places, the texture of the soil is loamy.

All of this mapping unit is in range. It is too rugged and too susceptible to erosion for cultivation but is well suited to pasture. The vegetation is mainly short and mid grasses, mostly western wheatgrass, vine-mesquite, blue grama, switchgrass, and scattered annuals. (Capability unit VIe–3; Mixed Hardland and Shallow range site)

Bippus Series

The Bippus series consists of deep, dark, granular loamy soils that have a moderately permeable subsoil. These soils are on smooth, gently sloping, concave valley floors below the caliche rims of the breaks and the limy soils on uplands. Nearly all of the acreage of Bippus soils in the county is in the rolling, dissected uplands in the southern and eastern parts.

The surface layer of these soils is dark grayish-brown clay loam, about 17 inches thick. It is friable and has granular structure. The subsoil, about 11 inches thick, is dark grayish-brown, calcareous clay loam. It has a granular structure and, when moist, is friable and crumbles easily. It is moderately permeable to air and water. Beneath the subsoil is calcareous, grayish-brown to brown loamy material several feet thick that is friable and porous. Mainly because of the high content of organic matter, and especially the large amount of activity by earthworms, these soils are fertile and porous. They are easily tilled when not too wet or too dry.

The parent material consists of moderately fine textured deposits of colluvium and alluvium that were brought from nearby slopes. In most places, these deposits are underlain by calcareous, coarse-textured outwash material. The soils formed under an abundant cover of mid and short native grasses, including side-oats grama, blue grama, and western wheatgrass.

Bippus soils occur on concave slopes below soils high in lime. Richfield and Mansic soils are at higher altitudes on convex to level upland areas. The Bippus soils are darker and more friable than the Richfield soils and are darker and deeper than the Mansic soils. They are in higher positions than the Spur soils and are more strongly developed.

Only one soil in the Bippus series was mapped in Beaver County.

Typical profile of Bippus clay loam, 1 to 3 percent slopes, in a cultivated field (east of the road and about 150 feet north and 135 feet east of the southwest corner of NW¼ sec. 28, T. 2 N., R. 22 E.):

A_{1p} 0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2.5/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; abrupt boundary.

A_1 7 to 17 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; strong, medium and fine, granular structure; slightly hard when dry, friable when moist; porous; many worm casts; noncalcareous; gradual boundary.

AC 17 to 28 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; compound moderate, medium, prismatic and fine and medium, granular structure; slightly hard when dry, friable when moist; strongly calcareous; gradual boundary.

C_{11} 28 to 39 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; compound weak, coarse, prismatic and fine, granular structure; slightly hard when dry, friable when moist; strongly calcareous; gradual boundary.

C_{12} 39 to 72 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard to soft when dry, friable when moist; porous; strongly calcareous.

Bippus soils vary in thickness of layers and in depth to calcium carbonate. On lower slopes the surface soil is generally noncalcareous, but calcareous material occurs at a depth of 6 to 20 inches. On the higher slopes the surface soil is lighter in color than on gentle slopes and is less deep to calcium carbonate. Spots of calcium carbonate in the lower part of the subsoil are barely noticeable in some places, but in other places soft concretions make up 5 percent of the soil material. Clay loam is the dominant texture, but small areas of loam and silt loam occur. The surface soil ranges from dark grayish brown (10YR 4/2, dry) to brown (10YR 5/3, dry). In some places a dark buried soil lies 2 to 6 feet below the surface.

Bippus clay loam, 1 to 3 percent slopes (BpB) is in long strips in valleys, below caliche escarpments and limy uplands (fig. 2). These strips are scattered through the rolling, dissected uplands in the southern and eastern parts of Beaver County. This soil has fairly uniform characteristics, but it includes small areas of other soils. Spur soils, which formed in recently deposited sediments, are adjacent to the draws or drainageways that cut the valley floor in places. Farther from the drainageways are small inclusions of Mansic soils.

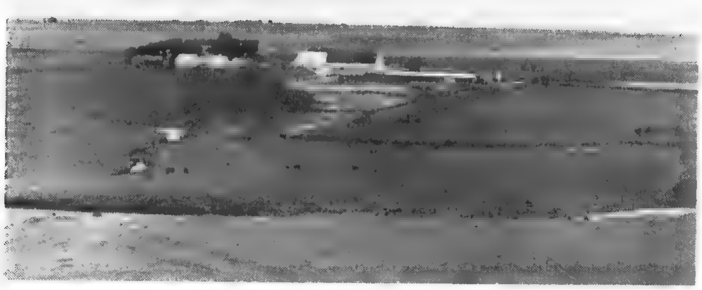

Figure 2.—**Farmstead in a valley containing Bippus soils.**

This soil is well drained, is permeable, and has a fairly high available moisture-holding capacity. It is slightly susceptible to wind and water erosion and needs fairly intensive dryland management to maintain fertility. Erosion is a problem where the soil is cultivated because water runs off the adjacent slopes. Most cultivated areas are slightly eroded, and some spots are moderately eroded.

Most of this soil is in crops, mainly wheat and, where moisture is adequate, sorghum. The small, narrow strips are used mostly as range. (Capability unit IIIe-1; Hardland range site)

Canadian Series

The Canadian series consists of deep, loamy or moderately sandy, well-drained soils that have a friable subsoil. These soils are smooth and nearly level. They are on low terraces and bottom lands along the major streams and rivers in the county.

The surface layer of these soils is dark grayish-brown, friable, granular fine sandy loam, about 16 inches thick. In some places a tillage pan has formed in this layer. The subsoil, a pale-brown, friable fine sandy loam, is underlain by very fine sandy loam stratified with sand and loam. Canadian soils are neutral to slightly calcareous in the surface layer and are increasingly calcareous with depth. They are permeable throughout their profile.

The parent material of the Canadian soils is sandy, stratified alluvium consisting of sediments sorted by water. These sediments were deposited on low terraces by floodwaters from adjacent streams. The native vegetation consisted of a dense cover of mid and tall grasses, mainly sand bluestem, little bluestem, switchgrass, and Indiangrass.

The Canadian soils occur with the Spur, Lincoln, and Las Animas soils. They are sandier than the Spur soils and are more stable and fertile than the Lincoln soils. They lack the subirrigated subsoil that is characteristic of the Las Animas soils.

Only one soil in the Canadian series was mapped in Beaver County.

Typical profile of Canadian fine sandy loam in a cultivated field (west of a road and about 1,212 feet west and 1,210 feet south of the northeast corner of NE¼ sec. 33, T. 6 N., R. 27 E.):

A_1 0 to 16 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; loose when dry, friable when moist; slightly calcareous; gradual boundary.

C_{11} 16 to 25 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; strongly calcareous; clear boundary.

C_{12} 25 to 42 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; weak, medium and fine, granular structure; slightly hard when dry, friable when moist; calcareous; clear boundary.

C_{13} 42 to 57 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, fine and medium, granular structure; slightly hard when dry, friable when moist; strongly calcareous.

The surface layer of Canadian soils in Beaver County is mostly fine sandy loam, but it ranges from light clay loam to loamy fine sand. When dry, it is brown (10YR 5/3) to very dark grayish brown (10YR 3/2). The sub-

Figure 3.—**Wheat pasture on Canadian fine sandy loam.**

soil is stratified in most places, and it ranges from light sandy loam to light loam. The depth to lime ranges from 0 to 20 inches.

Canadian fine sandy loam (0 to 1 percent slopes) (Cn) is a moderately dark, well-drained soil. It is on smooth, nearly level, low benches along streams. It has a profile like the one described for the series. Included with this soil are small areas of the sandy Lincoln and Las Animas soils and of the more clayey Spur soils. Also included are areas of Canadian soils that have a clay loam or loamy fine sand surface soil.

Canadian fine sandy loam absorbs and holds large quantities of water but is never waterlogged. This soil is moderately fertile and is suited to a wide variety of crops. It is easy to till, and all except a few narrow, poorly accessible strips are cultivated. Winter wheat and grain sorghum are the main dry-farmed crops; wheat is better suited than grain sorghum. Many irrigated areas are in alfalfa and produce excellent yields under good management (fig. 3).

Small areas of this soil are occasionally flooded for short periods. These floods cause little or no damage through erosion, but runoff from higher land may cause erosion in some places. The main problems of management are insufficient moisture and a slight susceptibility to wind and water erosion. Most of the cultivated acreage is slightly eroded, and about 10 percent is moderately eroded. If it is left bare, this soil erodes. It responds well to good management, which includes stubble mulching to prevent blowing. (Capability unit IIc–2; Sandy Bottom Land range site)

Carey Series

The Carey series consists of deep, friable, loamy soils. In Beaver County these soils are on smooth, nearly level to gently sloping uplands, mostly on the slopes south of the North Canadian River (locally called the Beaver River).

The surface layer is dark-brown, friable, granular silt loam, about 7 inches thick. The subsoil, about 25 inches thick, is reddish brown and is more clayey than the surface layer. It is friable, has a granular structure, and is moderately permeable to water and air. Below a depth of 32 inches, the soils are redder than in their upper part and contain concretions of calcium carbonate. These soils are easy to till if the content of water is favorable.

The parent material of the Carey soils is weathered siltstone, sandstone, and shale of the Permian red beds. The soils formed under a dense cover of native prairie grasses that consisted mostly of blue grama, side-oats grama, and little bluestem.

Carey soils occur with the Vernon, Woodward, and Mansic soils. They are deeper and more fertile than the Vernon soils and are deeper to lime than the Woodward and Mansic soils, which do not have a textural B horizon.

Typical profile of a Carey silt loam in a cultivated field (north of a road and about 354 feet west and 327 feet north of the southeast corner of SW¼ sec. 22, T. 4 N., R. 23 E.):

A_1 0 to 7 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; weak, granular structure; soft when dry, friable when moist; noncalcareous; gradual boundary.

B_2 7 to 15 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; distinct clay skins; soft when dry, very friable when moist; many worm casts; noncalcareous; clear boundary.

B_3 15 to 32 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky and weak, coarse, columnar structure; indistinct clay skins; porous; many worm casts; calcareous; soft concretions of calcium carbonate make up less than 1 percent of the lower part of horizon; clear boundary.

C_{ca} 32 to 54 inches, reddish-yellow (5YR 7/6) silty clay loam, reddish yellow (5YR 6/6) when moist; weak, fine to medium, granular structure; soft when dry, friable when moist; porous; many worm casts; calcareous; soft concretions of calcium carbonate make up less than 5 percent of horizon; concretions decrease in number with increasing depth.

The surface layer of Carey soils in Beaver County is mostly dark brown (7.5YR 4/2), but when dry it ranges from dark brown (10YR 4/3) to dark reddish brown (5YR 3/2). In most places, the surface soil is silt loam, but there are small areas of loam. The A_1 horizon, in most places, is 7 to 9 inches thick, but it ranges from 5 to 12 inches in thickness. It is about 7 inches thick in gently sloping areas and about 9 inches thick in the more nearly level areas. The depth to calcareous material ranges from 7 to 25 inches; the average depth is about 15 inches. The depth to the concretions of calcium carbonate is generally greater in the more nearly level areas. Normally, less than 5 percent of the soil material consists of concretions of calcium carbonate and, in many places, the carbonate zone is barely visible. The subsoil ranges from heavy silt loam to clay loam. Clay films on the peds in the subsoil are thin and are indistinct to prominent.

The Carey soils are well drained. They absorb water moderately well and have a fairly high available moisture-holding capacity.

Carey silt loam, 0 to 1 percent slopes (CaA) is a deep, silty, fertile soil that is well drained and easy to work. It occupies smooth, nearly level upland flats south of the Beaver River. This soil is similar to the one described for the series, except that it has a deeper surface layer in places.

Included with this soil in small, concave spots is a deeper, darker, more clayey soil that is similar to the Richfield soils. Also included are some calcareous soils similar to the Ulysses and Mansic soils, small areas of Woodward soils, and small areas of Carey soils with a loam surface soil.

Carey silt loam, 0 to 1 percent slopes, is permeable to roots, air, and water and has a fairly high available moisture-holding capacity. It is well suited to cultivation. Yields of wheat and grain sorghum are excellent when the weather is favorable and management is good.

Most of this soil is dry-farmed. It is well suited to irrigation, but only a small part of the acreage is now irrigated.

Wind erosion and the scarcity of rain are the main problems on this soil. Though erosion is mostly slight to moderate, it increases if the soil is abused or improperly managed. Where erosion has been active, the surface layer is lighter colored than in uneroded places. In many places, soil material accumulates along the fence rows.

A suitable cropping system includes crops that help to maintain soil fertility and to provide a protective cover during windy periods. Stubble mulching is effective in controlling erosion. (Capability unit IIc–1; Loamy Prairie range site)

Carey silt loam, 1 to 3 percent slopes (CaB) is on broad, smooth ridges in association with other Carey soils. It is shallower than Carey silt loam, 0 to 1 percent slopes, and slightly more susceptible to erosion. Particularly near the soil boundaries, some areas of Mansic and Woodward soils are included with Carey silt loam, 1 to 3 percent slopes.

Erosion is mostly slight, but small areas are moderately eroded. If fields are not protected by vegetation, wind blows away the surface layer of this soil and fertility is lost. Water erosion also damages open fields and in places cuts shallow rills and gullies in this soil after heavy rains. Plowing easily obliterates these gullies, but the lost soil is not so easily reclaimed.

Except for a few small, poorly accessible areas, this soil is in crops. Winter wheat is the main crop, but in good years, other plants are grown in a cropping system with the wheat.

Contour farming and a suitable cropping system that provides a protective cover help to maintain fertility and to prevent washing and blowing. Terraces are suitable in some places. (Capability unit IIIe–1; Loamy Prairie range site)

Dalhart Series

The Dalhart series consists of deep, friable, loamy soils that are rapidly permeable. These soils are smooth and nearly level to gently undulating. In Beaver County, they are in broad areas in the sandy plains of the northern part.

The surface layer is yellowish-brown to dark-brown, friable, granular fine sandy loam, about 10 inches thick. In many places, a tillage pan has formed in this layer. The subsoil, about 20 inches thick, is brown sandy clay loam that is porous and permeable. The soil material in this layer is arranged in coarse prisms that are friable and crush easily to a medium, granular structure. These soils are calcareous at a depth of 30 inches, and they grade to reddish-yellow sandy material below 43 inches.

The parent material of the Dalhart soils is calcareous, medium-textured to coarse-textured, wind-deposited material. These soils formed under a dense cover of mid and tall grasses and scattered sand sagebrush and yucca.

The Dalhart soils occur between the more clayey Richfield soils and the sandier Pratt soils. The subsoil in the Dalhart soils is sandier and less clayey than that in the Richfield soils. It is less sandy than the subsoil in the Pratt soils, which do not have a B horizon so distinct as in the Dalhart soils. The Dalhart soils are less limy than the Mansker soils and lack the prominent accumulation of lime in those soils. They are more sandy and less silty than the Ulysses soils.

Typical profile of a Dalhart fine sandy loam in a cultivated field (north of a road and about 50 feet east and 500 feet north of the southwest corner of SW¼ sec. 11, T. 5 N., R. 22 E.):

A_{1p} 0 to 6 inches, brownish-yellow (10YR 6/6) fine sandy loam and, on surface, a winnowed layer of stratified loamy fine sand, yellowish brown (10YR 5/6) when moist; single grain (structureless); noncalcareous; clear boundary.

A_1 6 to 10 inches, dark-brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; moderate, fine and medium, granular structure; loose when dry, friable when moist; noncalcareous; gradual boundary.

B_2 10 to 18 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, coarse, prismatic and moderate, medium, granular compound structure; indistinct clay films; very hard when dry, friable when moist; noncalcareous; gradual boundary

B_3 18 to 30 inches, strong-brown (7.5YR 5/8) sandy clay loam, strong brown (7.5YR 5/6) when moist; weak, coarse, prismatic and fine, granular compound structure; indistinct clay films; very hard when dry, friable when moist; mildly alkaline; clear boundary.

C_{ca} 30 to 43 inches, reddish-yellow (7.5YR 7/6) fine sandy loam, reddish yellow (7.5YR 6/6) when moist; weak, fine, granular structure to single grain (structureless); calcareous; white concretions of calcium carbonate make up 1 percent of horizon; clear boundary.

C 43 to 48 inches, reddish-yellow (7.5YR 8/6) loamy fine sand, reddish yellow (7.5YR 7/6) when moist; single grain (structureless); porous; less segregated lime than in C_{ca} horizon.

The surface layer of the Dalhart soils in Beaver County is mainly fine sandy loam, but small areas are loam and winnowed loamy fine sand. When dry, the surface soil ordinarily ranges from brownish yellow (10YR 6/6) to dark brown (10YR 4/3). In cultivated areas it is lighter colored because it contains less organic matter. Normally, the depth to carbonates ranges from 12 to 45 inches, but in some places these soils are mildy calcareous throughout. Older buried soils, normally darker in color, are common below 30 inches.

These soils absorb water readily and have a high available moisture–holding capacity. Little soil material is lost through runoff unless rains are heavy.

Dalhart fine sandy loam, 0 to 1 percent slopes (DaA) has a profile like the one described for the series. This soil is in smooth, nearly level areas in the sandy plains of the northern part of Beaver County. It is deep, friable, and

Figure 4.—**Stubble mulching in this area increases absorption of water and reduces wind and water erosion.**

loamy. Because the soil takes in water rapidy and runoff is slow, little soil material is lost through water erosion. The available moisture-holding capacity is high. Included with this soil are small areas of Richfield, Ulysses, and Mansker soils.

Most of this soil is in crops, and yields are excellent in good years. Wheat is planted in some places, but this soil is especially well suited to grain sorghum or forage crops. It is suitable for irrigation, but only a small acreage is now irrigated.

This soil needs to be managed so that the wind does not sift out fine particles of clay and organic matter and thereby lower fertility and increase the hazard of erosion. In small areas, the texture of the surface soil has already been changed from fine sandy loam to loamy sand. Erosion can be best controlled by maintaining continuous and adequate ground cover and by stubble mulching (fig. 4). A plowpan forms if this soil is plowed to the same depth or is plowed when it is too wet. (Capability unit IIIe-2; Sandy Plains range site)

Dalhart fine sandy loam, 1 to 3 percent slopes (DaB) occurs on gently undulating upland plains in the northern part of Beaver County. This soil occurs in fairly large, uniform areas between the more sandy Pratt soils and the more clayey Richfield soils. In areas where it intergrades to the Pratt soils, Dalhart fine sandy loam, 1 to 3 percent slopes, includes small areas of those soils. Also included are spots of the more limy Ulysses and Mansker soils.

In most places, Dalhart fine sandy loam, 1 to 3 percent slopes, is not eroded, but some places show signs of damage through erosion. In some cultivated areas, the surface soil is winnowed, coarse textured, and light colored because much of the clay and organic matter have been removed through erosion.

About 90 percent of this soil is in crops; the rest is mostly range. Because of the high moisture-holding capacity, high yields of grain sorghum are produced (fig. 5). Wheat yields are good if wind erosion is controlled by adequate use of stubble and plant residue.

Wind erosion is the main problem in maintaining the fertility of this soil in dryland farming. Crop residue incorporated in the soil and stubble left on the surface are the most effective methods of control. Water can be conserved efficiently by contour tillage and, where practicable, by terracing. A plowpan forms if this soil is tilled continuously at the same depth or is tilled when wet. Grazing should be regulated on pasture that is overgrazed or infested by sand sagebrush. (Capability unit IIIe-2; Sandy Plains range site)

Las Animas Series

The Las Animas series consists of dark, waterlogged soils on the flood plains of the main streams and rivers. These soils are undulating to nearly level. They are subirrigated by ground water that is normally within 3 feet of the surface.

The surface layer is dark-colored, loamy material, about 18 inches thick. It is friable, has a granular structure, and contains much organic matter. Beneath this is mottled, light yellowish-brown, stratified, sandy material, which ordinarily is saturated with water at a depth of less than 3 feet. The Las Animas soils are calcareous and contain salts.

Their parent material is weakly calcareous alluvium, which was washed from the surrounding uplands or was deposited by flood water. These soils are young and formed under a dense cover of water-tolerant grasses that consisted of Indiangrass, switchgrass, Canada wildrye, cordgrass, alkali sacaton, and little bluestem. The surface layer of these soils contains a large amount of organic matter formed from decaying plants.

The Las Animas soils are more fertile and less sandy than the Lincoln soils and, because of their higher water table, are less droughty than those soils. They differ from the Likes soils in position on the landscape and in having a subirrigated subsoil. The Las Animas soils are on flood plains, whereas the Likes soils are on foot slopes.

Only one soil in the Las Animas series was mapped in Beaver County.

Figure 5.—**Excellent yield of grain sorghum on Dalhart fine sandy loam, 1 to 3 percent slopes.**

Typical profile of a Las Animas soil (about 1,295 feet west and 50 feet north of the southeast corner of NW¼ sec. 10, T. 4 N., R. 23 E.):

A_{11} 0 to 5 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium to fine, granular structure; hard when dry, friable when moist; high in organic matter; calcareous; many roots; clear boundary.

A_{12} 5 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium to fine, granular structure; hard when dry, friable when moist; calcareous; many roots; clear boundary.

AC 10 to 18 inches, brown (7.5YR 5/4) silt loam, dark brown (7.5YR 4/4) when moist; moderate, medium to fine, granular structure; hard when dry, friable when moist; calcareous; many roots; abrupt boundary.

C_{11} 18 to 22 inches, light yellowish-brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) when moist; single grain (structureless); calcareous; clear boundary.

C_{12} 22 to 25 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; weak, granular structure; calcareous; clear boundary.

C_{13} 25 to 45 inches, very pale brown (10YR 7/4) loamy fine sand, light yellowish brown (10YR 6/4) when moist; single grain (structureless); thin lenses of stratified sandy clay loam mottled with yellowish brown; calcareous; water table at 25 inches.

The Las Animas soils in Beaver County are normally saturated with water within 3 feet of the surface, but in prolonged droughty periods, the depth to ground water may increase to 4 or 5 feet. The depth depends mainly on the amount of rainfall and the distance from a stream channel. These soils are generally saline, but in some places the accumulation of salts is greater than in others. The upper part of the profile is highly calcareous or neutral. The depth to sandy material ranges from less than 15 to 30 inches or more. Stratification in the upper layers varies.

The surface layer of these soils is mainly silty clay loam, but in small areas, it is loam and silt loam. When dry, its color ranges from brown (10YR 5/3) to dark grayish brown (10YR 4/2). Poor drainage is indicated by the yellowish-brown or olive-brown mottles in the subsoil.

These soils are occasionally flooded, and small areas have been damaged by floodwater. Other small areas have been destroyed where the stream channels have changed their course.

Las Animas soils (0 to ½ percent slopes) (La) are poorly drained. Large areas are scattered along the flood plains of the Beaver and Cimarron Rivers, and smaller areas are along the channels of spring-fed creeks in all parts of the county. These soils are nearly level but contain a few sinkholes where water stands in wet seasons and attracts migrating wildlife.

Las Animas soils are ridged or slightly undulating because water causes the soil material to settle. The surface layer is dark, is fertile, and contains much organic matter. Below a depth of 30 to 40 inches, the substratum contains stratified, waterlogged, sandy material. Included with these soils are some areas of Lincoln soils and of deep soils consisting of dark, more clayey, alluvial material.

Floodwaters occasionally cover these soils but generally do little harm. The damage that does occur is mostly where an adjacent stream channel changes its course and cuts away the vegetation, but this seldom happens.

***Figure 6.*—Cover of native grass on Las Animas soils. Under good management, these soils produce a large and dependable amount of forage for livestock.**

Less than 3 percent of the acreage of these soils has been cleared for cultivation, and less than 1 percent is now in crops. Because they are wet and salty, Las Animas soils are not suited to cultivation. They are, however, among the best soils in the county for range. If management is good, their fertility and supply of moisture make them well suited to water-tolerant grasses (fig. 6).

Farmers and ranchers use these grassy areas for pasture and hay meadow. Good management of these areas includes control of grazing. In well-managed areas, the vegetation consists of a dense cover of suitable grasses, but in heavily grazed areas, saltgrass, weeds, alkali sacaton, and other unwanted plants predominate. (Capability unit Vw-2; Subirrigated range site)

Likes Series

The Likes series consists of loose, calcareous, sandy soils that in this county are mainly on the concave foot slopes of the sandhills, along the Beaver and Cimarron Rivers. These soils occur below the Tivoli, Otero, and Pratt soils and above the alluvial soils on the lowlands.

The surface layer of the Likes soils in dark-brown loamy fine sand, about 14 inches thick. The subsoil is loose, yellowish-brown, strongly calcareous loamy sand that extends to a depth of 40 or more inches. It is porous, is droughty, and transmits water rapidly.

The parent material of Likes soils is sandy, coarse-textured material that has rolled or washed from higher, sloping, sandy soils. The native vegetation is mid and tall grasses and scattered sand sagebrush.

The Likes soils occur with the Las Animas, Pratt, and Tivoli soils. They lack the subirrigated subsoil that is characteristic of Las Animas soils and occur on foot slopes instead of on the flood plains. Their calcareous subsoil distinguishes them from the Pratt and Tivoli soils. The Likes soils have a sandier subsoil than the rolling Otero soils. They are more sloping than the Lincoln soils and are not flooded as are those soils.

Only one soil in the Likes series was mapped in Beaver County.

Typical profile of Likes loamy fine sand (about 510 feet west and 50 feet south of the northeast corner of NE¼ sec. 9, T. 4 N., R. 23 E.) :

A 0 to 14 inches, dark-brown (10YR 4/3) loamy fine sand, dark brown (10YR 3/3) when moist; single grain (structureless); loose when dry, friable when moist; noncalcareous; gradual boundary.

C 14 to 40 inches, light yellowish-brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) when moist; single grain (structureless); loose when dry, loose when moist; strongly calcareous.

Most areas of Likes soils are fairly uniform, but the surface layer is calcareous in some areas. The surface layer is generally loamy fine sand but, in a few areas, is fine sandy loam. In a few places the C horizon is stratified with layers of fine sand.

These soils take in water rapidly, but in dry seasons they are droughty because their capacity for storing moisture is low.

Likes loamy fine sand (1 to 5 percent slopes) (Lf) has a profile like the one described for the series. This soil is in long, fairly narrow areas on concave slopes. The average slope of these areas is about 3 percent. Included with this soil are small areas of Tivoli, Pratt, and Lincoln soils. The Tivoli and Lincoln soils make up less than 5 percent, and the Pratt soils as much as 15 percent, of some areas.

This soil is best suited to permanent pasture, and most of it is used for that purpose. It is not suitable for cultivation, because it is droughty and susceptible to erosion. Less than 5 percent of this soil has been cleared for cultivated crops, and less than 1 percent is now cropped. The sandy surface soil quickly loses fertility under cultivation, and yields are low.

Good pasture management includes prevention of overgrazing and maintenance of desirable grasses. Sand sagebrush infests areas that are heavily grazed, but under good management, the amount of sand bluestem, little bluestem, switchgrass, and Canada wildrye increases. (Capability unit VIe-6; Deep Sand range site)

Lincoln Series

The Lincoln series consists of deep, sandy soils that are forming in recently deposited alluvium. In Beaver County, these soils occupy the narrow bottom lands of streams that flow from the upper plains. They are unstable because new material is deposited on them by floodwaters.

These soils vary in texture, color, and depth. In most places, the surface layer is grayish-brown, calcareous loamy sand, about 15 inches thick. This layer is underlain by light grayish-brown, strongly calcareous sand that is highly stratified with clay and silt. Below a depth of 36 inches is pale-brown, loose, noncalcareous sand with splotches caused by iron rust.

The Lincoln soils are very young and are in the process of forming. Their soil material consists of sand, gravel, silt, and clay, which were washed by floodwaters from higher slopes in the uplands and deposited where the stream current is slow. Flooding leaves fresh sand and loamy deposits on the surface of these soils, and vegetation has little time to become established because of the recurrent floodwaters. The vegetation is mostly weeds, alkali sacaton, and switchgrass. Next to the stream channels are woody shrubs and a few willow and cottonwood trees.

Lincoln soils occur with the Spur and Canadian soils. They are not subirrigated. They are more sandy and less stable than the Spur and Canadian, and because they are less fertile, they do not produce so much forage.

Only one soil in the Lincoln series was mapped in Beaver County.

Typical profile of a Lincoln soil in a pasture (about 1,700 feet south and 1,050 feet west of the northeast corner of NE¼ sec. 31, T. 5 N., R. 25 E.) :

A_1 0 to 15 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; splotched with brown; weak, granular structure; thin lenses of loamy sand; diffuse boundary.

AC 15 to 25 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; single grain (structureless); noncalcareous; clear boundary.

C_{11} 25 to 36 inches, light brownish-gray (10YR 6/2) sand, containing thin bands of finer material; grayish brown (10YR 5/2) when moist; massive (structureless); mottles of iron rust; strongly calcareous; gradual boundary.

C_{12} 36 to 52 inches, very pale brown (10YR 7/3) loose sand, pale brown (10YR 6/3) when moist; single grain or massive (structureless); noncalcareous; mottled with rust.

The Lincoln soils have a coarse, sandy subsoil. Their surface soil is mostly loamy fine sand, which, in swales or in areas near slowly moving streams, is intermingled with sandy loam, silt loam, clay loam, and loam. The texture of an area depends on the soils in the surrounding areas from which soil material is washed. When dry, these soils are grayish brown (10YR 5/2), brownish yellow (10YR 6/6), and reddish yellow (7.5YR 6/6). In most places the upper part of the profile is calcareous, and in many places fragments of gravel are on the surface and are scattered through the profile.

The Lincoln soils are on low flood plains next to stream channels and are often inundated by floodwaters. Drainage is rapid. The water table is generally 8 feet or more below the surface, but in some places it is about 5 feet. In dry seasons the depth is 10 feet or more.

Lincoln soils (0 to 1 percent slopes) (Ln) occupies the narrow, fairly unstable, low flood plains along the streams in the uplands of Beaver County. These soils include riverwash in adjoining channels. Other inclusions are small areas of the neighboring soils. These inclusions are mostly Likes, Pratt, and Otero soils but are partly Canadian, Spur, and Las Animas soils.

Frequent flooding of the sandy flood plains makes Lincoln soils variable in texture and unstable. They are not suited to crops and are not farmed. Vegetation is sparse because these soils are wet when floods occur and are droughty in dry periods. Only small areas provide forage for livestock. Lincoln soils are also susceptible to blowing.

The scattered vegetation consists mostly of woody shrubs, annuals, sand sagebrush, switchgrass, and alkali sacaton, and next to stream channels are a few cottonwood trees. Saltgrass and willows grow in a few areas that have seepage water. Natural reseeding and the establishment of suitable forage can be assisted by controlling

grazing. (Capability unit VIe-1; Sandy Bottom Land range site)

Mansic Series

The Mansic series consists of deep, dark, loamy soils on gently sloping to moderately sloping uplands. In Beaver County these soils are in the southern and the eastern parts. They occur at elevations above the soils that formed in material weathered from Permian red beds and below the soils that formed on the level High Plains.

The surface layer of these soils is dark grayish-brown clay loam, about 15 inches thick. Where it contains enough moisture, it is friable and has a granular structure. When dry, the surface layer is loose and ashy and is highly susceptible to erosion. Beneath this layer is a grayish-brown subsoil of clay loam, about 8 inches thick. The soil material in this layer is arranged in coarse prisms that are friable and are easily crumbled to granules. It is porous and permeable to water and air. Below a depth of 23 inches, the soil structure is weak and the soil contains a few concretions of lime. Below 40 inches is less friable, massive, and lighter colored soil material that is highly calcareous.

Mansic soils formed in medium-textured, highly calcareous outwash sediments of the High Plains. This parent material contains an appreciable amount of grit, and grit is prominent in the profile of the Mansic soils. The native vegetation was blue grama, side-oats grama, little bluestem, and other grasses.

Mansic soils have a more friable subsoil than the Richfield soils and do not have the textural B horizon that occurs in those soils. They have a less distinct accumulation of calcium carbonate than have the Mansker soils. The Mansic soils formed in deep residuum of the outwash plains, whereas the Woodward soils formed in partly weathered residuum of the red beds. Thus, the Mansic soils are gray or brown, and the Woodward soils are red.

Typical profile of a Mansic clay loam in a cultivated field (south of a road and about 350 feet south and 145 feet east of the northwest corner of NW¼ sec. 35, T. 2 N., R. 27 E.):

A_{1p} 0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; soft when dry, very friable when moist; many worm casts; porous; permeable; calcareous; gradual boundary.

A_1 6 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; strong, fine and medium, granular structure; coarse, prismatic structure when dry; slightly hard when dry, friable when moist; many worm casts; porous; permeable; calcareous; gradual boundary.

AC 15 to 23 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse, prismatic and medium, granular compound structure; slightly hard when dry, friable when moist; many worm casts; porous; calcareous; gradual boundary.

C_{ca} 23 to 40 inches, light yellowish-brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) when moist; weak, medium, granular structure to almost massive (structureless); strongly calcareous; few soft concretions of lime; clear boundary.

C 40 to 52 inches, light yellowish-brown (10YR 6/4) light clay loam, yellowish brown (10YR 5/4) when moist; strongly calcareous; few concretions of lime in upper part; fine and medium quartz sands.

The surface layer is 12 to 20 inches thick; it varies according to the degree of slope and the effects of erosion. When this layer is dry it is mostly dark grayish brown (10YR 4/2), but near Gate and along the county line to the east, it is less gray and more brown or is dark brown (10YR 3/3). Also, where these soils occur with Woodward soils, they are more brown in the surface layer and subsoil. In these places, the substratum, when dry, is more red or is yellowish red (5YR 5/6). The plow layer in the more sloping, cultivated Mansic soils is generally lighter in color, and the A horizon is thinner than normal.

The texture of the surface soil of Mansic soils in Beaver County is dominantly clay loam, but in a few places it is loam or silt loam. In some areas, the upper few inches of the A_1 horizon is noncalcareous. The depth to visible lime varies from 15 to 25 inches. A C_{ca} horizon may or may not be recognized, for accumulations of lime range from 1 to 10 percent. In some profiles the C horizon is a sandy clay loam that contains some fragments of gravel.

Mansic clay loam, 1 to 3 percent slopes (McB) is a deep soil on uplands. It occurs in Beaver County with Richfield soils and with other Mansic soils on moderate slopes in the southern and eastern parts. Included with this soil on low slopes are small areas of the Richfield soils. The profile of this soil is similar to the one described for the series, but the surface layer is thicker in places. In cultivated, more nearly level areas, the thickness of the surface soil is more consistent than it is on the steeper slopes, probably because the soil is less affected by erosion in the more nearly level areas. Also, fewer shallow, limy spots occur in the cultivated areas.

Nearly all of this soil is cultivated. Wheat is the main crop, but grain sorghum is grown when the weather is favorable.

This soil needs good management to maintain its fertility under dryland farming. Unprotected areas blow severely and wash after heavy rains. Most cultivated areas have slight erosion, but a few small areas are moderately eroded. The main problems of management are the susceptibility to erosion, insufficient moisture, and a gradual decrease in fertility if cultivation is continuous. (Capability unit IIIe-1; Hardland range site)

Mansic clay loam, 3 to 5 percent slopes, eroded (McC3) is on the moderately sloping uplands, mostly in the southeastern part of the county. Many areas are as large as 1 square mile. Smaller areas are near Gate in the northeastern part of the county. This soil occurs between the smoother soils on the High Plains and the soils that formed in material weathered from the red beds. Here, small areas of the associated Richfield and Woodward soils are included with Mansic clay loam, 3 to 5 percent slopes, eroded.

The surface layer of this soil has been thinned through erosion and is lighter colored than that in the profile described. Light-colored spots that include some of the Mansker and Potter soils are common on the peaks of slopes where the erosion is most severe. In these areas all of the surface soil and, in places, the subsoil have been removed, and erosion has left much lime and caliche at the surface. Though severely eroded areas make up less than 5 percent of this soil, nearly all of it is more than slightly eroded. Uneroded areas are mostly in native grass.

Figure 7.—**Unprotected field containing Mansic clay loam, 3 to 5 percent slopes, eroded. Because vegetation is sparse, this soil blows severely after a heavy, cutting rain.**

In most cultivated areas the surface soil has been thinned through erosion and the lighter colored subsoil has been mixed with it by tillage. If this soil is not protected and its fertility conserved, it will become worthless for crops. In dry seasons the unprotected soil blows as if it were flour (fig. 7). At the bottom of slopes, water erosion has formed rills and shallow gullies. To conserve soil and water, leave plant residue on this soil, provide terraces, and till on the contour. Stubble mulching is a practical way to maintain a protective cover. (Capability unit IVe–1; Hardland range site)

Mansic soils, severely eroded (McC4) is mostly on strong slopes where runoff is excessive. Wind and water erosion have been more severe on these soils than on the other Mansic soils. Included with this mapping unit are intermingling strips of severely eroded Mansker, Richfield, and Potter soils.

Sheet erosion has removed all of the dark-colored original surface layer and, in places, part of the subsoil. At the surface is raw, limy material and caliche that retards the percolation of water and increases runoff and erosion. Shallow rills and gullies that cannot be crossed by farm machinery are common.

These soils are not suited to cultivation. The larger areas have been cultivated, but yields decreased and the fields were abandoned or reseeded to grass (fig. 8). Small areas along drains make suitable grassed waterways to receive water from the adjoining terraced fields. To control further loss of soil, it is best to protect eroded areas by permanent grass. Suitable grasses consist of side-oats grama, little bluestem, blue grama, and buffalograss. (Capability unit VIe–2; Shallow range site)

Mansic-Otero complex, 1 to 3 percent slopes (MoB) consists of Mansic soils and Otero soils that are so intermingled that it is not practical to map them separately. About 65 percent of the complex consists of Mansic soils and about 35 percent of Otero soils. This complex is on gently undulating to undulating, moderately sandy uplands, mostly in the southern and eastern parts of Beaver County.

The Otero soils are strongly calcareous and sandy. Their surface layer is dark colored and averages about 8 inches in thickness. Beneath this is a layer of slightly cohesive loamy sand, about 12 inches thick, that grades abruptly to loose, strongly calcareous, sandy material. The surface layer of Mansic soils is fine sandy loam or loam, about 13 inches thick. Beneath this the subsoil is loam or clay loam. Below a depth of about 32 inches, the subsoil grades to strongly calcareous, sandy material. Representative profiles of the Otero soils and of the Mansic soils are described in the Otero and Mansic series.

The Otero soil soaks up water rapidly, but the available moisture-supplying capacity is low because the subsoil is porous and sandy. Runoff is generally low, and the lower lying Mansic soil catches most of the excess water. The Mansic soils are moderately permeable and have a fairly high available moisture-supplying capacity.

Most areas of this complex occur with areas of steeper and rougher soils that are in grass, and ranchers and farmers who need land to grow feed crops clear this complex for cultivation.

The Mansic-Otero complex is generally not suited to contour tillage or terracing. The main problems in farming are conservation of moisture and control of wind erosion. Erosion in cultivated areas is generally slight, but about 10 percent of the cultivated acreage has moderate erosion. The Otero soils on mounds or ridges, especially on west-facing slopes, are more severely eroded than are the soils in other places. Grain sorghum is the best suited crop, and where moisture is adequate, yields are good. Yields of winter wheat are fairly good if all plant residue is left on the fields. (Capability unit IVe–2; Limy Sandy Plains range site)

Mansic-Woodward complex, 1 to 3 percent slopes (MwB) consists of Mansic and Woodward soils so intermingled that it is not practical to map the soils separately. About 70 to 80 percent of the complex is Mansic soils and about 20 to 30 percent is Woodward soils. The percentage varies from place to place, and the percentage in Woodward soils increases on the lower slopes. This complex is between areas of more sloping Mansic and Woodward

Figure 8.—**Grass on Mansic soils, severely eroded.**

soils and areas of soils that formed in residuum of Permian red beds at the lower elevations. The unit has small inclusions of Mansker and gravelly Potterlike soils at the summits of the areas, normally adjacent to the Mansic soils. Small areas of Carey soils are adjacent to the Woodward soils in the complex.

This mapping unit occurs on gentle slopes and is well drained. It is productive and well suited to cultivation. About three-fourths of the acreage is in crops, and the rest is in pasture. Winter wheat is the principal crop, but sorghum can be grown with fair success when moisture is adequate.

Soil erosion is the main problem when these soils are cultivated. If tillage is excessive, the soil material is pulverized and the ashy surface layer erodes severely. Sheet erosion is the main problem, and a few shallow gullies or rills form in fields during heavy rains. The gullies can be removed by tillage, but much soil fertility is lost. Most cultivated areas are slightly eroded, but only about 10 percent of the cultivated acreage is moderately eroded.

Contour cultivation and planting of crops that will add residue and protect the soil are good conservation practices. In some places terraces are needed, and in windy seasons a plant cover is especially helpful. (Capability unit IIIe-1; Hardland range site)

Mansic-Woodward complex, 3 to 5 percent slopes, eroded (MwC3) occupies moderately sloping areas in association with the Woodward-Mansic complex. About 70 percent of this complex consists of Mansic soils; 15 percent, Woodward soils; and 15 percent, Mansker, Potter, and Carey soils.

Erosion is a serious problem in cultivated areas and has already thinned the soils considerably. In many places, the plow layer consists of subsoil material. Wind erosion is a problem during droughts if vegetation is not maintained. Damage from water erosion is greatest in the shallow, branching rills and drains that lie between the slopes. Some of these shallow washes are obliterated by tillage, but a few are too big to be so removed. Because they are steeper, the Mansic soils are more eroded than the Woodward soils. The subdued knolls in the area are the most severely eroded.

This mapping unit includes some shallow Mansker soils and some gravelly areas in which the soil material resembles the Potter soils. In these inclusions, all of the dark-colored surface layer and most of the subsoil have been lost, and lighter colored, limy material and many small rocks cover the surface. These severely eroded areas make up about 5 percent of the mapping unit. Most of this complex is moderately eroded. Uneroded areas are mostly in native grass.

About 85 percent of this mapping unit is in cultivation. Some of it has been reseeded to grass, and the rest is in native pasture. The grasses on well-managed native pasture are mostly blue grama, side-oats grama, and little bluestem. Winter wheat is the principal crop, but sorghum can be grown when moisture content is adequate.

Unless management is good, these soils will become worthless for crops. To maintain soil fertility and to control wind erosion, cultivate on the contour, build terraces, and make use of all plant residue. (Capability unit IVe-1; Hardland range site)

Mansker Series

The Mansker series consists of grayish-brown, calcareous, loamy soils that have a subsoil high in lime. Slopes are gentle to moderate. These soils are on shallow caliche beds in all parts of Beaver County.

The surface layer of these soils is grayish-brown, friable clay loam, about 6 inches thick. It has a granular structure. The subsoil, about 10 inches thick, is strongly calcareous clay loam. When moist, this layer breaks into prisms that crush easily to granules. The surface layer and the subsoil are permeable to air, water, and roots. The subsoil grades to a less permeable, very pale brown substratum that contains a very large amount of chalky white lime and caliche.

The Mansker soils formed in strongly calcareous, loamy earth on the High Plains. They developed under a dense cover of native short grasses, mainly side-oats grama, blue grama, and buffalograss.

The Mansker soils occur mainly with the Ulysses, Dalhart, Richfield, Mansic, and Potter soils. They are more shallow than the Ulysses soils and contain more lime. The Mansker soils are deeper to beds of indurated caliche than the Potter soils and lack the moderate textural B horizon characteristic of the Richfield soils. Mansker soils are more clayey and less sandy than the Dalhart soils, which do not have a prominent accumulation of lime.

Typical profile of a Mansker clay loam in native pasture (east of a road and about 150 feet south and 25 feet east of the northwest corner of NW¼ sec. 34, T. 2 N., R. 23 E.):

A_1 0 to 6 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many worm casts; strongly calcareous; clear boundary.

AC 6 to 16 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) when moist; strong, coarse, prismatic and medium, granular compound structure; slightly hard when dry, friable when moist; many worm casts; strongly calcareous; concretions of lime make up about 1 percent of horizon; gradual boundary.

C_{ca} 16 to 42 inches, very pale brown (10YR 8/3) clay loam, very pale brown (10YR 7/3) when moist; massive (structureless); hard when dry, friable when moist; few worm casts in upper part; strongly calcareous; soft to slightly indurated concentrations of lime make up 15 percent of upper part of horizon and about 35 percent of lower part.

The surface soil is grayish brown to brown in color and is mostly clay loam in texture, but in a few places the texture is loam or silt loam. The depth to lime ranges from 10 to 30 inches; the amount of concretions ranges from 15 to 40 percent of the soil mass. Some concretions are hard to very hard.

Runoff is moderate to rapid, depending on the grade of slope and vegetation. Permeability is moderate in the upper layers but is slow in lower layers, which are high in lime. Though the Mansker soils are well drained and absorb water readily, they have a low moisture-holding capacity because their solum is thin.

Mansker clay loam, 1 to 3 percent slopes (MaB) is a moderately deep, gently sloping soil. It is in small areas between the Ulysses soils and the more shallow Potter soils on the rims of the High Plains. It includes areas of Ulysses soils and Potter soils and scattered areas of the

less limy Mansic soils. Variations are not so great in this soil as in Mansker clay loam, 3 to 5 percent slopes.

Since areas of this soil are small, they are managed the same as adjacent soils, and areas next to deeper soils are cultivated. Wheat is the main crop, but grain sorghum, forage sorghum, and sudangrass can be grown when moisture is adequate.

Mansker clay loam, 1 to 3 percent slopes, requires good management to maintain its fertility under dryland cultivation. The main agricultural problems are the severe hazard of erosion, crop failure because of insufficient moisture, and a rapid decline in fertility under continuous cultivation. Erosion is mostly slight, but small areas are moderately eroded. In the more severely eroded spots, the limy subsoil has been mixed with the surface soil through tillage. (Capability unit IIIe-1; Hardland range site)

Mansker clay loam, 3 to 5 percent slopes (MaC) occurs on moderate, uneven slopes. Many small areas of this soil are at the crest of slopes above the Mansic soils, and some areas of Mansic soils are included with it. Other areas occur with the shallow Potter soils, which contain caliche below a depth of about 5 inches.

If this soil is allowed to erode, the surface soil is thinned rapidly. Erosion is slight to moderate in most cultivated areas. Areas that are moderately eroded have a lighter colored surface soil than that in uneroded areas because much of the limy caliche has been mixed with it.

This soil is difficult to cultivate because the slopes are uneven, erosion is a problem, and the surface layer varies in depth. Only small areas that are next to deeper soils have been cleared and cultivated. Because of the severe erosion hazard, many of these plowed areas have been reseeded to grass.

Though this soil is poorly suited to cultivation, it is well suited to grass and is among the best soils in the county for range. Excellent yields of forage are produced if good range management is provided. Suitable grasses are little bluestem, side-oats grama, blue grama, switchgrass, and Canada wildrye. (Capability unit IVe-1; Hardland range site.)

Mansker-Potter complex (3 to 20 percent slopes) (Mp) consists of Mansker soils and Potter soils so intermingled that it is not practical to map them separately. About 40 percent of the complex consists of stony Potter soils, and about 60 percent consists of Mansker soils on eroded breaks and of small areas of other soils. Some areas of this complex occupy steep erosional areas that are capped with soils having rocklike caliche near the surface. Other areas occur on the rugged rims and drains of the High Plains and include exposures of fractured, indurated caliche. On the foot slopes or aprons within the Mansker-Potter complex are Bippus soils, which are deep, dark, and loamy.

The Mansker soils are moderately shallow and calcareous. Under permanent pasture, their surface soil is grayish-brown, granular clay loam, about 6 inches thick. Beneath this, the subsoil is light brownish-gray clay loam that, below a depth of 16 inches, grades abruptly to a layer that contains much lime. A profile of a representative Mansker soil is included in the description of the Mansker series.

The Potter soils are stony and have a thin surface soil. This layer is grayish-brown clay loam or loam, about 5 inches thick. Beneath this is hard, rocklike, fractured caliche.

The Mansker soil in this mapping unit formed in limy and weakly cemented sediments, whereas the Potter soil formed in caliche or in a mixture of calcareous earth and indurated lime. The Mansker soil is deeper than the Potter soil and contains less indurated caliche. These soils developed under a mixture of grasses consisting mostly of blue grama, buffalograss, side-oats grama, little bluestem, hairy grama, and forbs.

Typical profile of a Potter soil in a pasture (968 feet west and 27 feet north of the southeast corner of SE¼ sec. 27, T. 2 N., R. 23 E.):

A 0 to 5 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; medium-sized pebbles of lime in the soil mass; weak, granular structure; strongly calcareous; abrupt boundary.

D_r 5 to 25 inches, white, fractured, hard or indurated caliche.

When dry, the surface layer of this soil ranges from dark grayish brown (10 YR 4/2) to brown (10 YR 5/3). The depth to caliche ranges from 2 to 10 inches, and the bed of caliche ranges from 5 inches to 10 feet or more in thickness. In some areas stones of hard, rocklike caliche as much as 1 foot in diameter are on the surface.

Included in the Mansker-Potter complex are unmapped areas of Ulysses, Bippus, Mansic, and Richfield soils. Also in the complex are eroded exposures of caliche and raw earth.

Runoff from the steep, rugged areas of this complex is rapid and causes floods, but runoff from the longer, smoother areas is retarded by fairly dense vegetation. Internal drainage in the Mansker soils is moderate. Permeability in the Potter soils is fair in the upper few inches, but the substratum of caliche impedes penetration of water and plant roots.

This mapping unit is not suited to cultivation and is mostly in pasture. Prairie grasses yield good forage, but much of the native grass under which the complex formed has been thinned by overgrazing. Side-oats grama is dominant, but there are other short grasses and traces of little bluestem. Little bluestem is thicker in well-managed areas than in poorly managed areas.

Overgrazing and water erosion are the main problems on steep breaks. In many places water forms deep gullies in cattle trails, and little vegetation can gain a foothold because plant residue and litter are rapidly lost. To divert water from adjoining areas, provide diversion structures. Good management of grazing is needed on the Mansker-Potter complex to prevent deterioration of pasture. Restrict the number of livestock, limit grazing by fencing, and distribute locations for water and salt. Because this complex is low in available moisture-holding capacity, grass quickly deteriorates in dry periods. (Capability unit VIe-3; Mixed Hardland and Shallow range site)

Otero Series

The Otero series consists of loose, sandy, calcareous soils that are rapidly permeable. In Beaver County these soils occupy irregular relief and moderate slopes on the

rolling sandy ranges in the northern and eastern parts. Smaller areas are in the southwestern corner.

The surface soil is grayish-brown, granular, calcareous sandy loam, about 6 inches thick. The underlying subsoil, about 10 inches thick, is friable, brown, strongly calcareous, and sandy. This layer is lighter colored than the horizon above and is loose, calcareous, loamy sand.

The parent material of the Otero soils is sandy, calcareous material deposited by water during the Tertiary geological period. These soils developed under mid and tall grasses and scattered sand sagebrush.

The Otero soils occur with Mansic and Pratt soils, and in this county, most areas of Otero soils are mapped in complexes with those soils. The Otero soils are lighter colored and more sandy than the Mansic soils and, unlike the Pratt soils, are highly calcareous in the upper 24 inches. The Otero soils are less sandy than the Likes soils and are lighter colored and more sandy than the Mansker soils.

Typical profile of an Otero soil (about 615 feet south and 25 feet east of the northwest corner of NW¼ sec. 26, T. 3 N., R. 27 E.):

A_1 0 to 6 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; many roots; large amount of organic matter; loose when dry, friable when moist; slightly calcareous; gradual boundary.

AC 6 to 16 inches, pale-brown (10YR 6/2.5), slightly cohesive loamy sand, brown (10YR 5/3) when moist; moderate, coarse, prismatic and weak, medium, granular structure; loose when dry, friable when moist; strongly calcareous; gradual boundary.

C 16 to 38 inches, very pale brown (10YR 7/3.5) loamy sand, light yellowish brown (10YR 6/4) when moist; single grain (structureless); loose when dry, friable when moist; strongly calcareous.

When dry and in native grass, the surface soil ranges from dark grayish brown (10YR 4/2) to dark brown (10YR 4/3) or brown (7.5YR 5/4). These soils lose humus rapidly under cultivation and become lighter colored. The texture in most places is sandy loam but is winnowed loamy sand in many cultivated areas. Under native vegetation the surface layer ranges from 5 to 18 inches in thickness. The subsoil is light sandy clay loam or sandy loam, 10 to 24 inches thick. Lime in the substratum may be in the form of films or soft caliche, or it may be mixed in the weakly consolidated sand. Concretions of calcium carbonate make up as much as 20 percent of the soil mass. Though in most places the soils are calcareous throughout, the upper 4 or 5 inches is neutral or weakly calcareous in a few profiles.

The Otero soils take in water rapidly but have a low available moisture-holding capacity. They are droughty because their subsoil lacks fine-textured material that would store the moisture.

Otero soils, 3 to 5 percent slopes, eroded (OtC3) are sandy and limy. About 10 percent of this mapping unit is made up of Mansker soils, about 5 percent of Mansic soils, and about 5 percent of Potter soils. The Mansker inclusions are normally on ridgetops and on rims close to the drainageways. Lower down are the Mansic soils, and the Potter soils are at the top of small knolls.

Because of erosion and the variability in the stratified parent material, the texture of the surface soil varies considerably but is mostly fine sandy loam, loam, or loamy fine sand. Though most of the soils in the mapping unit are moderately eroded to severely eroded and small areas are very severely eroded, as much as 15 percent consists of uneroded native range. Wind and water erosion have been active on Otero soils, 3 to 5 percent slopes, eroded, and much drifting of the surface soil has occurred. Many small rills run down the slopes.

***Figure 9.*—Scanty vegetation on Otero soils, 3 to 5 percent slopes, eroded. Wind erosion has removed much of the surface layer, has greatly reduced fertility, and has allowed the soil to blow.**

Most of this mapping unit has been cleared and planted to feed crops for livestock. When it was first plowed, the soil material was kept in place by grass roots, humus, and fine particles of silt and clay. After a few years of crops, the grass roots and humus disappeared because the soil was too droughty to produce ample cover in dry periods. Then erosion further reduced fertility (fig. 9). The eroded soils are lighter colored than the soil described in the profile representative of the Otero series.

In places, erosion has sifted the soil to the extent that the surface layer has changed from sandy loam to coarse loamy sand. Blowouts occur in the more severely eroded areas, and the fertility of the soil is greatly reduced. Many fields now lie idle or have been reseeded to grass. To prevent further damage, it is best to reseed the soils and keep them under permanent grass. It may be difficult, however, to establish an adequate cover because of lack of moisture. Suggested for reseeding are little bluestem, side-oats grama, blue grama, switchgrass, and sand bluestem. (Capability unit VIe-4; Limy Sandy Plains range site)

Otero-Mansker complex (Om) consists of Otero soils and Mansker soils so intermingled that it is not practical to map them separately. This mapping unit is extensive in the southeastern part of the county and is mostly in range. Calcareous, loamy and sandy Otero soils are dominant in the complex. The Mansker soils are shallow to moderately deep, contain much lime, and are loamy. This complex ranges from gently sloping to sloping, and, in places, it is cut by ravines or sand-filled drainageways.

In most places this mapping unit consists of about 60 percent Otero soils, 20 percent Mansker soils, 8 percent Mansic soils, 5 percent Potter soils, 5 percent Pratt soils, and 2 percent Lincoln, Tivoli, and Bippus soils.

The surface layer of the Otero soils is grayish-brown to dark grayish-brown sandy loam, as much as 18 inches

thick. The subsoil is brown to pale-brown loamy sand that is loose, droughty, and strongly calcareous.

The surface layer of the Mansker soils is dark grayish-brown, calcareous clay loam, about 5 inches thick. It is friable and has a granular structure. The subsoil of grayish-brown clay loam has a coarse, prismatic structure that crushes easily to a granular structure. This layer is strongly calcareous and contains a few concretions of lime. From a depth of 9 inches to 24 inches, the soil material is massive, very pale brown clay loam and the concretions of lime make up 15 to 40 percent of the soil mass. Below 24 inches, the soil material consists of very pale brown loamy sediments and the amount of lime is less than in the upper part of the profile.

Turn to the description of the Otero series for a profile representative of the Otero soils, and to the Mansker series for one representative of the Mansker soils.

Because it is fairly shallow and is highly susceptible to erosion, the Otero-Mansker complex is not suited to cultivation. Most of it is in range. The native vegetation consists of little bluestem, sand bluestem, side-oats grama, blue grama, buffalograss, and scattered sand sagebrush. A few scattered bunches of yucca occur on these soils, and three-awn invades heavily grazed areas.

Breaks in the terrain of this complex protect livestock in winter. Well water is abundant in most low places, but sites for stock ponds must be chosen carefully because the soil material is sandy and porous. The best management for this complex provides protection from overgrazing. (Capability unit VIe-4; Limy Sandy Plains range site)

Otero-Pratt fine sandy loams, 3 to 12 percent slopes (OpD) consists of Otero fine sandy loam and of Pratt fine sandy loam so intermingled that it is not practical to map them separately. This complex is mostly in the northern and eastern parts of Beaver County, on dunes and sharp ridges and in deep ravines and natural drainageways. Large areas are in other parts of the county as well.

The Otero soil makes up 65 percent of the complex, and the Pratt soil makes up about 30 percent. The remaining 5 percent consists of Tivoli, Lincoln, Likes, Mansker, and Potter soils. The Otero soil is on moderate slopes and is intermingled with the Pratt soil on hummocks and dunes. The Mansker and Potter soils are along the breaks or upper slopes, and the Tivoli soils are on dunes near river bottoms or streams. On the narrow sandy flood plains of drainageways are the Lincoln soils. Turn to the series description of these soils for descriptions of representative profiles.

The Otero soil has a surface layer of grayish-brown fine sandy loam, as much as 18 inches thick. The subsoil is pale-brown, strongly calcareous loamy sand that is loose and droughty. The vegetation consists mainly of side-oats grama, blue grama, little bluestem, sand bluestem, and switchgrass..

The surface layer of the Pratt soil is dark-brown or dark yellowish-brown fine sandy loam, about 12 inches thick. Beneath this is a yellowish-brown fine sandy loam subsoil that is permeable and has moderate moisture-holding capacity. Sand bluestem provides good grazing in well-managed areas of the Pratt soil, but overgrazing has thinned the desirable grasses in many areas and sand sagebrush has invaded.

Because of their coarser textured subsoil, the more shallow areas of the Otero soils are more droughty and less productive that the Pratt soils. Runoff ranges from moderate to rapid on this mapping unit, depending on the slope and amount of vegetation.

The Otero-Pratt complex is not suited to cultivation but is well suited to range. The terrain is excellent for ranches, and the breaks and ravines provide protection for livestock in winter. Well water for livestock is abundant in most low places, but sites for ponds must be chosen carefully because the soil material is sandy and porous. The best management for range provides protection from overgrazing, because sand sagebrush and less desirable grasses quickly infest pasture that is grazed heavily. Suitable grasses for overseeding are little bluestem, side-oats grama, blue grama, switchgrass, and sand bluestem. (Capability unit VIe-5; Sandy Plains range site)

Pratt Series

The Pratt series consists of deep, rapidly permeable, moderately sandy soils. In Beaver County these soils are on the broad, rolling, sandy plains in the northern part. Their surface layer is dark colored, ranges from fine sandy loam to loamy fine sand, and is about 12 inches thick. In some places a tillage pan forms in this layer. The subsoil, about 20 inches thick, is moderately coherent and permeable; it grades to light-colored, loose, structureless sandy material.

The Pratt soils formed in sandy, coarse-textured, wind-blown deposits under a dense cover of mid and tall grasses and scattered sand sagebrush.

Pratt soils occur with Dalhart, Otero, and Tivoli soils. They have a sandier subsoil than the Dalhart soils and are fairly free of the lime that occurs in the Otero soils. They have more clay in the subsoil than the incoherent Tivoli soils and are darker and thicker in the surface layer.

Throughout the areas of Pratt soils in this county there are imperfectly drained depressions that are too small to map separately. These depressions form a network of streaks or bands, and they are darker and contain more clay than the Pratt soils.

Typical profile of Pratt fine sandy loam, undulating, in a cultivated field (east of a road and about 1,320 feet south and 134 feet east of the northwest corner of NW¼ sec. 25, T. 6 N., R. 20 E.):

A_{1p} 0 to 12 inches, dark yellowish-brown (10YR 4/4) fine sandy loam, dark yellowish brown (10YR 3/4) when moist; weak, fine to medium, granular structure; soft when dry, very friable when moist; noncalcareous; plowed boundary.

B_2 12 to 32 inches, yellowish-brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) when moist; contains about 5 percent more clay than A_{1p} horizon; weak, fine to medium, granular structure; noncalcareous; gradual boundary.

C_1 32 to 40 inches, light yellowish-brown (10YR 6/4) loamy fine sand containing thin lenses of sand, yellowish brown (10YR 5/4) when moist; weak, granular structure; soft when dry, very friable when moist; noncalcareous; gradual boundary.

C_2 40 to 54 inches, light yellowish-brown (10YR 6/4), medium and fine sand, yellowish brown (10YR 5/4) when moist; single grain (structureless); loose; noncalcareous.

The Pratt soils vary mainly in color, content of calcium carbonate, thickness of horizons, and the amount of clay in the subsoil. In general, the less sloping areas are darker in color to a greater depth and are more clayey in

the subsoil. When dry, the surface layer ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4). On knolls and ridges and in cultivated fields, this surface layer has lost large amounts of organic matter and is lighter in color than elsewhere. When dry, the subsoil ranges from light yellowish brown (10YR 6/4) to brown (7.5YR 5/3). The Pratt soils are noncalcareous in the A_1 and B_2 horizons, but in a few places they are weakly calcareous below a depth of 30 inches.

The texture of the surface layer ranges from fine sandy loam to loamy fine sand, and that of the subsoil, from loamy fine sand to heavy fine sandy loam. Normally, the subsoil is heavy fine sandy loam in areas that have a fine sandy loam surface layer. In some places a darker and older buried soil occurs below a depth of 30 inches.

Pratt fine sandy loam, undulating (2 to 6 percent slopes) (PfB) occupies gently undulating slopes in the northern part of Beaver County, between the more level soils of the High Plains and the soils on sandy dunes. Included with this soil are small areas of Dalhart and Otero soils and of Pratt loamy fine sand.

Pratt fine sandy loam, undulating, is permeable to water, air, and plant roots. Water penetrates this soil rapidly, and its good moisture-holding capacity favors the growth of plants. It has little runoff except during intensive rains, and this runoff is generally absorbed or is trapped in swales before it reaches drainageways. Normally, these swales contain darker, more clayey soil material, and in wet seasons they may interfere with tillage.

This soil is especially well suited to sorghum, and wheat yields are fair in good crop years. About 60 percent of this soil is dry-farmed; most of the rest is permanent pasture. Under good management, pasture produces a large amount of forage, but sand sagebrush and less desirable grasses infest the pasture if it is overgrazed.

This soil is highly susceptible to wind erosion, especially in clean-tilled fields. Although considerable wind erosion has already occurred in places, little permanent damage has been done. If the soil is allowed to blow, it rapidly loses its fine clay and humus; consequently, the surface layer is coarser, more erodible, and less fertile in some places than in others. In many places the surface layer is winnowed to a depth of 2 to 6 inches. Careful management is needed to prevent excessive wind erosion (fig. 10).

***Figure 10.*—Stubble of grain sorghum left on a field to protect the soil from blowing in winter.**

Protect and improve the soil by leaving a maximum amount of residue on the surface and by maintaining continuous vegetation or stubble mulching. (Capability unit IVe-2; Sandy Plains range site)

Pratt loamy fine sand (2 to 6 percent slopes) (Pr) is a deep soil that is highly susceptible to erosion. It occurs on low hummocks or nearly level to moderate, undulating slopes on the uplands; most of it is gently sloping. This soil is between the sandy dunes and the gently undulating soils of the sandy plains.

Included with this soil is a network of small, poorly drained swales and depressions in which the soil material is darker and more clayey. In wet seasons, water collects and stands in these low areas and makes tillage difficult. Also included are small areas of fine sandy loam and of Dalhart and Otero soils.

Pratt loamy fine sand is a loose, sandy soil that soaks up water rapidly and has a moderate available moisture-holding capacity. It supplies moisture to forage crops better than do some of the hardland soils. Because of the susceptibility of this soil to wind erosion, farming is difficult and only small areas have been cleared for cultivation. Unprotected areas blow severely in windy seasons, and humus and clay are rapidly removed from the soil, which is then lower in fertility and less resistant to erosion. Some cultivated fields show signs of wind erosion. Their surface layer is lighter colored and coarser textured than in uneroded areas, and there are small blowouts. Erosion, however, is mostly slight; only about 10 percent of this soil is moderately eroded.

This soil can be cultivated if well managed, but it is best suited to pasture. Allow a maximum amount of crop residue to stand on this soil in winter and use stubble mulching. Prevent overgrazing to keep less desirable grasses and sand sagebrush from invading. (Capability unit IVe-2; Deep Sand range site)

Pratt-Tivoli loamy fine sands (Pt) is a complex of soils that lie in a gradational area between large areas of Tivoli soils and of Pratt soils. Large areas of this mapping unit are in a band north of the Tivoli soils on the north bank of the Beaver River, and south of the less sloping Pratt soils on the undulating, sandy plains. This complex occupies dunes, some of which are more than 25 feet high. The Pratt soils are on the lower part of the cone-shaped dunes, and the Tivoli soils are on the top of the dunes.

The Pratt soil makes up about 75 percent of this complex and the Tivoli soil about 20 percent. The rest of the complex consists of dark, clayey soil material in poorly drained, scattered depressions.

In this complex, the Pratt soil has a grayish-brown loamy fine sand surface soil and a yellowish-brown loamy fine sand subsoil. The Tivoli soil has a light brownish-gray loamy fine sand surface layer and a loose subsoil of structureless fine sand. Turn to the series descriptions of the Pratt and the Tivoli soils for descriptions of representative profiles.

Pratt-Tivoli loamy fine sands are permeable and soak up water rapidly. Little runoff occurs except during intensive rains, and excess water is generally absorbed before it reaches the drainageways.

Because it is steep, loose, and susceptible to erosion, this sandy complex is not suited to cultivation. All of it

is used for range and, where well managed, produces high yields of forage. Many pastures are made up largely of this mapping unit, and they need carefully controlled grazing that will maintain the permanent cover required to prevent blowouts. Heavily grazed areas are rapidly infested by sand sagebrush. (Capability unit VIe-6; Deep Sand range site)

Pullman Series

The Pullman series consists of deep, dark soils that have a compact, clayey subsoil. In Beaver County these soils are on broad, smooth, nearly level areas in the southern plains.

The surface layer of these soils is dark grayish-brown clay loam, about 7 inches thick. It has a granular structure and is friable, permeable, and easily tilled when the moisture content is favorable. A plowpan has formed in some places. The subsoil, about 29 inches thick, is compact and is less permeable and more clayey than the surface layer. The soil material in the subsoil is dark brown and is arranged in shiny blocks that have continuous clay films on the surface. When pressure is applied, these blocks crumble to medium and fine granules. Below a depth of 36 inches, the subsoil grades abruptly to lighter colored, highly calcareous, loamy material.

The parent material of these soils was deposited by wind and is silty, moderately fine textured, and calcareous.

The Pullman soils formed under a dense cover of native short grasses, mostly western wheatgrass, side-oats grama, blue grama, and buffalograss. Because of this dense cover, the surface layer is moderately high in organic matter.

The Pullman soils occur with the Richfield, Ulysses, and Randall soils and formed from parent material similar to that of those soils. The Pullman soils are less silty than the Ulysses or Richfield soils and have a more compact, clayey subsoil. They are more nearly level than the Randall soils, which are in depressions or on floors of playa lakes.

Only one soil in the Pullman series was mapped in Beaver County.

Typical profile of Pullman clay loam in a cultivated field (north of a road and about 660 feet north and 69 feet east of the southwest corner of SW¼ sec. 34, T. 1 N., R. 22 E.):

A_{1p} 0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium to fine, granular structure; hard when dry, friable when moist; noncalcareous; many roots; abrupt boundary.

B_2 7 to 21 inches, dark-brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; strong, coarse, blocky structure crushing to weak, medium to fine, granular; clay films continuous; noncalcareous; roots between peds; very hard when dry, very firm when moist; abrupt boundary.

B_3 21 to 36 inches, yellowish-brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) when moist; porous; weak, medium to coarse, blocky structure; slightly hard when dry, friable when moist; calcareous; segregated lime over the surface of peds.

C_{u1} 36 to 48 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; pseudo mycelia; lime films; strongly calcareous; clear boundary.

C_{u2} 48 to 65 inches, reddish-yellow (7.5YR 6/6) silty clay loam, strong brown (7.5YR 5/6) when moist; massive (structureless); porous; slightly calcareous.

The Pullman soils have fairly uniform characteristics, but their depth to calcareous material ranges from 15 to 40 inches or more. The content of clay is higher in deep profiles than in shallow ones and extends to a greater depth. In this county, these soils are mostly clay loam, but silt loam occurs in small areas in native range. The structure of the surface layer is normally granular, but under cultivation the structure is generally weakened and is then platy in the lower part. A plowpan forms in many cultivated areas. Buried soils of different kinds occur in some places below a depth of 30 inches.

The Pullman soils are moderately well drained; they absorb and store large quantities of water. Though water soaks slowly into their heavy, clayey subsoil, runoff is retarded because these soils are nearly level, or in places, slightly concave. The water that does soak in moves slowly into playa lakes and indistinct drainageways.

Pullman clay loam (0 to 1 percent slopes) (Pm) is commonly called a hardland wheat soil. It is on the High Plains along the southern boundary of the county, in smooth, nearly level areas. Most of it occurs in one broad area that extends across several square miles and is bordered on the north by the Richfield and Ulysses soils. Scattered over the area are playa lakes, which are occupied by Randall soils. Where Pullman clay loam is near Richfield and Ulysses soils, it includes small areas of those soils.

This soil is deep and productive. Nearly all of it is in crops, and though it is slightly susceptible to erosion, most cultivated areas are only slightly eroded. When weather is favorable, this soil produces excellent yields of wheat (fig. 11) and grain sorghum. It is well suited to irrigation, and many fields are irrigated with excellent results.

Droughtiness caused by the scarcity of rainfall is the main problem in farming, and it is increased by a plowpan and poor structure. Erosion can be easily controlled by plowing under soil-building crops, by tilling on the contour, and by leaving plant residue on the surface. To prevent blowing, stubble mulch and roughen the surface

Figure 11.—**Excellent yield of wheat on Pullman clay loam, which has had adequate moisture.**

of this soil. (Capability unit IIIc–1; Hardland range site)

Randall Series

The Randall series consists of deep, clayey soils. In Beaver County, these soils are on the slightly concave floor of the saucerlike depressions that are scattered in the upland plains. In wet seasons, water collects and stands in these depressions, which are locally called dry lakes or playa lakes.

These soils are stiff and compact. The surface layer is grayish clay, about 30 inches thick, that has a weak, blocky, almost massive, structure. Beneath this layer is gray or grayish-brown, compact clay that extends through the rest of the profile and is almost the same color as the surface layer.

The parent material of the Randall soils is fine-textured alluvium that washed from the surrounding uplands or was deposited by drainage water. The native vegetation consists mostly of western wheatgrass, short grasses, and annual grasses.

Randall soils occur with Richfield, Pullman, Dalhart, and other soils on level parts of the High Plains. Randall soils are more nearly massive through the profile than those soils and are on the floors of playa lakes instead of in higher parts of the High Plains.

Only one soil in the Randall series was mapped in Beaver County.

Typical profile of Randall clay in range (930 feet north and 1,540 feet west of the southeast corner of SE¼ sec. 29, T. 1 N., R. 23 E.):

A 0 to 30 inches, dark-gray (N 4/0) clay, very dark gray (N 3/0) when moist; weak, blocky structure to massive (structureless); very sticky and stiff when wet, very firm when moist, very hard when dry; noncalcareous; roots present; clear boundary.

C_{11} 30 to 41 inches, gray (N 5/0) clay, dark gray (N 4/0) when moist; mottled slightly with brown; very compact and structureless; few concretions of calcium carbonate, but soil material is noncalcareous; decaying roots; gradual boundary.

C_{12} 41 to 50 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive (structureless); distinctly mottled with pale yellow; more concretions of calcium carbonate than in horizon above, but concretions make up less than 1 percent of horizon, and soil material is noncalcareous.

In this county, the Randall soils vary in thickness from about 2 feet in the small depressions to several feet in the large ones. The A and C_{11} horizons range from neutral to strongly calcareous. Except for yellowish mottles below a depth of 30 inches, these soils are gray or grayish brown.

Randall clay (Ra) is on the floor of saucer-shaped playa lakes, in the nearly level, upland plains of Beaver County. In the valley northeast of Gate, a 600-acre area of Randall clay occurs. Most areas of this soil, however, range from 5 to 50 acres in size and are generally 15 to 25 acres. This soil is 2 to 8 feet thick; it is thicker in large areas than in small areas.

The soil is compact, clayey, and very slowly permeable to almost impervious. It contracts when dry and swells when wet. In dry periods, the lakes dry up and large cracks form a network on the floor of the lakebed; in wet seasons, water collects and drowns all vegetation. When the water evaporates from the lakebeds, in prolonged droughts or dry summers, vegetation invades the shoreline.

Randall clay is not suited to cultivation; its best use is pasture. Most large areas are in range, and the small areas are generally managed in the same way as the surrounding soils.

If runoff water from the surrounding uplands can be controlled, this soil would make good pasture. Western wheatgrass is the best grass to plant in reclaiming these lake bottoms. (Capability unit Vw–1; Hardland range site)

Richfield Series

The Richfield series consists of deep, dark, loamy soils on smooth, nearly level to moderately sloping uplands. These soils are on the High Plains and are in the rolling terrain below these plains. On the High Plains they are nearly level, and below the High Plains they are gently sloping to moderately sloping.

These soils are friable and easily tilled when their moisture content is adequate. Their surface soil is dark-colored, granular loam to clay loam, about 7 inches thick. In some places, a tillage pan forms in this layer. The subsoil, about 29 inches thick, is dark-brown silty clay loam. It has a subangular blocky structure and is slowly permeable to air and water. Below a depth of 36 inches is moderately fine textured loamy material that contains some soft concretions of lime.

The parent material of the Richfield soils is silty, calcareous, moderately fine textured loess. These soils formed under a dense cover of short grasses, side-oats grama, blue grama, western wheatgrass and buffalograss.

Richfield soils occur with the Pullman, Ulysses, Dalhart, Randall, Mansic, Bippus, and Mansker soils. On the High Plains they occur with the Dalhart and Randall soils, and below these plains they occur with the Mansic, Bippus, and Mansker soils. They do not occupy depressions, as do the Randall soils, and they are less sandy in the surface soil than the Dalhart soils. Richfield soils have a more friable subsoil than the Pullman soils, and a less friable subsoil than the Mansic and Ulysses soils. They do not have the accumulation of lime that characterizes the Mansker soils. Richfield soils are less friable and lighter colored than the Bippus soils, which are on concave slopes below areas of limy soils.

Typical profile of a Richfield clay loam (east of a road and about 100 feet east and 50 feet south of the northwest corner of SW¼ sec. 9, T. 1 N., R. 23 E.):

A_1 0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure to a depth of 4 inches and strong, medium, granular structure below; hard when dry, friable when moist; noncalcareous; clear boundary.

B_2 7 to 21 inches, dark-brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; strong, medium to fine, subangular blocky structure; clay films pronounced but not continuous; hard when dry, firm when moist; noncalcareous; clear boundary.

B_3 21 to 36 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; weak, medium and coarse, blocky structure; patchy clay films; hard when dry, moderately firm when moist; porous; calcareous; clear boundary.

C_{ca} 36 to 53 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; massive (structureless); few segregated concretions of lime.

When dry, the A_1 horizon ranges from dark grayish brown (10YR 4/2) or dark brown (10YR 4/3) to dark brown (7.5YR 4/2) in color and from 4 to 22 inches in thickness. The texture of the surface soil ranges from clay loam to loam or silt loam, and that of the B_2 horizon, from clay loam to silty clay loam. Free carbonates occur at a depth of 10 to 35 inches.

In areas below the breaks of the High Plains, the entire profile contains a considerable amount of fine and medium sand and the soil material below the B horizon is less silty and more sandy than in other places. The surface soil is granular in areas of native grass above the breaks of the High Plains, where the soil is more silty. In cultivated fields, it is platy and commonly has a tillage pan.

The Richfield soils are well drained. Surface runoff is slow to rapid, but permeability in the moderately compact subsoil is medium for air and water. The runoff drains into playa lakes or indistinct drainageways above the broken areas of the High Plains and into natural drains below the caprock areas.

Richfield loam, thick surface (0 to 1 percent slopes) (Rt) is one of the best soils in this county for farming. Its loam surface layer is about 15 inches thick and is deeper than the surface layer of other Richfield soils. This soil is on the broad, smooth, nearly level, upland plains in the northern part of Beaver County. Extensive areas occur near Floris and Turpin in the northwestern part. Between Knowles and Gate in the northeastern part, there are some nearly level places. Included with this soil are small areas of Dalhart, Ulysses, and Randall soils.

This soil is deep, friable loam that is easily tilled. Except for a few areas under irrigation, almost all of it is dry-farmed. Because it is fertile, it is suited to a wide variety of crops, and nearly all crops suited to the area are grown. Small grains and grain sorghum are the main crops; wheat is the most dependable grain.

Though cultivated areas are slightly eroded, this soil can be cultivated successfully if erosion is controlled and soil and water are conserved. Scarcity of moisture is the main problem in farming this soil. (Capability unit IIIc-1; Hardland range site)

Richfield clay loam, 0 to 1 percent slopes (RcA) is in broad, smooth, nearly level areas in the upland plains of the southwestern part of Beaver County. It occurs between the Pullman soils on the flats and the Ulysses soils along the natural drainageways of the High Plains. Included with this soil are small areas of Dalhart, Ulysses, and Randall soils. The Randall soils are in the scattered playa lakes. Runoff is slow, and it drains into these playa lakes and indistinct drainageways.

This soil is deep and friable and is among the best in the county for farming; most of it is in crops. Winter wheat is the main crop (fig. 12), but grain sorghum can be grown when moisture is adequate.

A scarcity of moisture is the main problem in farming, but if this soil is irrigated and well managed, all crops suited to the county can be grown. Another problem is a slight susceptibility to erosion in cultivated areas. A tillage pan forms in places if plowing is at the same depth or is not at the right time. Practices to conserve moisture and to control erosion are fairly easy to apply. (Capability unit IIIc-1; Hardland range site)

Figure 12.—**Harvesting wheat on Richfield clay loam, 0 to 1 percent slopes.**

Richfield clay loam, 1 to 3 percent slopes (RcB) occurs in fairly small areas above the breaks of the High Plains and in extensive areas below the caprock. Areas of this soil range from 20 to 200 acres in size. These areas are generally on fairly long, smooth slopes of about 2 percent. Included with this soil are areas of Ulysses and Mansker soils that are too small to map separately. Also associated are other Richfield soils. Small amounts of these neighboring soils are mapped with Richfield clay loam, 1 to 3 percent slopes.

The surface layer of this soil has a wider range in thickness than the more nearly level Richfield soils; it is 5 to 10 inches thick. Increased erosion on the stronger slopes probably causes this variation. Much of this soil is slightly eroded, and about 10 percent is moderately eroded.

Most of this soil is dry-farmed. Winter wheat is the main crop, but sorghum can be grown where moisture is adequate.

This soil is slowly permeable, has greater runoff than the more nearly level Richfield soils, and is more susceptible to erosion. Water erosion is the main problem. After heavy rains, sheet erosion is severe and, in places, a few shallow rills form. This erosion washes away the surface layer and its organic matter. The surface is then more susceptible to crusting, and the soil structure breaks down so that permeability is slower and the hazard of further erosion is greater. Also, the soil is poorer for seedbeds.

This soil needs management to control water and wind erosion, to maintain organic matter, and to improve the rate of moisture intake. Suitable practices are management of crop residue, stubble-mulch tillage; farming on the contour, and, in some places, building of terraces. (Capability unit IIIe-1; Hardland range site)

Richfield-Mansic clay loams, 3 to 5 percent slopes (RmC) are in large areas on the rolling, dissected uplands of the south-central and the eastern parts of Beaver County. This mapping unit consists of Richfield clay loam intermingled with small, narrow bodies of Mansic clay loam. It is on moderate, fairly long slopes, mostly

adjacent to natural drainageways. Though it is steeper and shallower, the Richfield soil in this complex is similar to the more nearly level Richfield soils. The Mansic soil is like the soil described for the Mansic series except that it is browner in many places. About 65 to 80 percent of this complex consists of Richfield soil, and about 15 to 35 percent, of Mansic soil. On sharp slopes or near drainageways, however, the Mansic soil is dominant.

Areas of this complex are rather broad; some cover an entire square mile. About 90 percent is cultivated and is mainly in wheat, but grain sorghum can also be grown where moisture in the subsoil is adequate.

The moderately strong slopes of this complex are susceptible to severe erosion because runoff is rapid during intensive rains, especially on unprotected soils. In pasture or well-managed fields, the surface soil is dark, friable, and not marked by rills or gullies, but in areas where erosion has been active, the soil is lighter in color, crusts easily, and has shallow rills. Though these rills are easily obliterated by normal plowing, the loss of soil is a problem and needs to be controlled. (Capability unit IVe-1; Harland range site)

Spur Series

The Spur series consists of deep, dark, friable, loamy soils that are well drained. In Beaver County these soils are on smooth, nearly level, low stream terraces, on the flood plains of streams.

The surface layer of these soils is about 12 inches thick and is dark-brown clay loam that is friable, has a granular structure, and is easy to till. Beneath this layer, the subsoil is dark-brown clay loam, which has a strong, granular structure but is friable and crumbles easily when moist. In most places these soils are calcareous through the profile. Below a depth of 22 inches, they are lighter in color, less friable, and contain segregated lime. These soils have a moderately high available moisture-holding capacity and, because of earthworm activity, are fertile and permeable to air and water.

The parent material of the Spur soils consists of medium- and fine-textured, water-sorted material that was deposited by floodwaters from nearby streams. These soils formed under a dense cover of native tall and short grasses, mainly switchgrass, little bluestem, sand bluestem, western wheatgrass, blue grama, and side-oats grama.

The Spur soils are in lower positions than the Bippus soils and are not so well developed. They are darker and less sandy than the Canadian soils.

Typical profile of a Spur soil in a cultivated field (south of a road and about 1,056 feet west and 60 feet south of the northeast corner of NW¼ sec. 28, T. 4 N., R. 23 E.):

A_{1p} 0 to 6 inches, dark-brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many worm casts; weakly to moderately calcareous; plowed boundary.

A_1 6 to 12 inches, dark-brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many worm casts; weakly calcareous; clear boundary.

AC 12 to 22 inches, dark yellowish-brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) when moist; strong, fine, granular structure; slightly hard when dry, friable when moist; many worm casts; moderately calcareous; gradual boundary.

C 22 to 42 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; few worm casts; strongly calcareous; segregated lime, mostly in old root channels; very porous, but less porous and less limy below 42 inches.

The surface layer of the Spur soils in Beaver County ranges from loam to clay loam in texture and, when dry, from very dark grayish brown (10YR 3/2) to dark brown (10YR 4/3) in color. The subsoil, when dry, ranges from dark grayish brown (10YR 4/2) to reddish brown (5YR 5/4). A darker colored buried soil is below a depth of about 2 feet in some places. In other places below a depth of 25 inches are stratified sandy loam and loamy soil materials. Some profiles are darker than others, and in some places the subsoil is redder than elsewhere. Generally the Spur soils are calcareous, but in a few places, mostly under permanent grass, they are noncalcareous in the top few inches. In some areas the profile shows practically no development, and in others it is moderately developed.

Spur soils (0 to 1 percent slopes) (Sp) are on smooth, nearly level flood plains along the main creeks and rivers in Beaver County. The texture of the surface layer varies considerably but ranges mainly from loam to clay loam. Included in the mapping unit are small areas of Bippus and Canadian soils.

Spur soils are porous, permeable to air and water, and moderate to high in available moisture-holding capacity. Their smooth, friable surface soil is easy to work. These soils are high in natural fertility and are well suited to agriculture, but they are slightly susceptible to wind erosion. Most of the mapping unit is somewhat eroded.

Except for a few narrow strips, Spur soils are in crops. Winter wheat is the main dry-farmed crop, and alfalfa, the main irrigated crop (fig. 13). Alfalfa helps produce good structure by breaking up plowpans, by preventing crusting and blowing, by increasing water intake and water-holding capacity, and by maintaining organic matter and plant nutrients. When moisture is adequate, yields of small grains and sorghum are excellent.

Floodwaters occasionally cover these soils, but little damage is done because the soils are flooded for only short periods. In a few places runoff from higher land causes

Figure 13.—**Harvesting alfalfa hay on an irrigated Spur soil.**

erosion. Diversion terraces are generally effective, however, in controlling this water erosion. Conservation practices are easy to apply on these soils to maintain productivity and to control erosion. (Capability unit IIc–2; Loamy Bottom Land range site)

Tivoli Series

The Tivoli series consists of deep, loose, structureless, sandy soils in the sandhills. These soils are in irregular strips, 1 to 3 miles wide, on the northern bank of the Beaver River. The hills and ridges are 20 to 60 feet high, and their slopes are mostly greater than 12 percent.

The surface layer of the Tivoli soils is loose fine sand, about 8 inches thick. This is underlain by reddish-yellow, loose and porous, wind-sifted sand of almost the same color as the surface layer. The parent material of the Tivoli soils is loose, wind-deposited, fine and medium sand. This material is free of lime and was probably blown from the streambeds to the south.

The sandhills occupied by the Tivoli soils have not been held in place long by vegetation and do not support a grass cover heavy enough to provide much organic matter. There is, however, a small accumulation of organic matter in these soils. The native vegetation consists mainly of tall grasses and scattered sand sagebrush, skunkbrush, wild grape, and wild plum.

The Tivoli soils occur with the Pratt and the Likes soils. The subsoil of the Tivoli soils is less coherent than that of the Pratt soils, and the surface layer contains much less organic matter. They lack the calcareous subsoil of the Likes soils. Intermingled with the Tivoli soils in depressions are soils more clayey than the Tivoli.

Typical profile of Tivoli fine sand in a pasture (1,025 feet south and 50 feet west of the northeast corner of SW¼ sec. 4, T. 4 N., R. 22 E.):

A_1 0 to 8 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) when moist; single grain (structureless); loose when dry, loose when moist; roots; noncalcareous; very porous and permeable; gradual boundary.

C 8 to 60 inches, reddish-yellow (7.5YR 6/6) fine sand; strong brown (7.5YR 5/6) when moist; single grain (structureless); loose when dry, loose when moist; few roots; noncalcareous; very porous and permeable.

The Tivoli soils have fairly uniform characteristics. Their main variations are in color and in the thickness of the surface layer. When dry, the surface layer ranges from brown (10YR 5/3) to brownish yellow (10YR 6/6), depending on the content of organic matter. In some places the surface layer is as much as 12 inches thick, but it is much thinner in heavily grazed areas or where vegetation is thin. The subsoil is reddish yellow (7.5YR 6/6) to brownish yellow (10YR 6/6) when dry. These soils are normally noncalcareous through the profile and do not contain free lime.

Though the Tivoli soils are droughty, their loose, porous soil material absorbs water rapidly, and little moisture is lost through runoff or evaporation. Light rains that fall on the sandhills penetrate to plant roots, and even in intensive rains, most runoff water is absorbed before it reaches the drainageways.

Tivoli fine sand (12+ percent slopes) (Tv) is in large areas on the northern bank of the Beaver River. The surface layer of this soil is loose, structureless, and erodible sand that contains only a thin accumulation of organic matter. This layer is underlain by sandy material.

This steep, sandy soil is suited only to pasture. In most places, grasses are sparse and do not entirely prevent wind erosion. Included with this soil are small active dunes that contain little or no vegetation. Also included is a darker and more clayey soil in a few scattered depressions that have a fairly dense cover of grass.

This sandy soil drifts freely if there is not enough vegetation to keep it in place. Grazing, especially in droughty periods, is limited and requires special management. Prevention of overgrazing is important because it will help maintain a protective cover. Areas that are heavily trampled by livestock are especially subject to blowouts. (Capability unit VIIe–1; Dune range site)

Ulysses Series

The Ulysses series consists of friable, silty, nearly level to moderately sloping soils. In Beaver County, these soils occupy the broad, undulating, upland plains.

These soils have a dark grayish-brown silt loam surface soil, about 6 inches thick. It is friable and has a granular structure. The subsoil, about 9 inches thick, is also dark grayish brown, but it is more clayey than the surface soil. This layer contains coarse prisms that crush easily to granules when pressure is applied. In the layers below the subsoil, the soil material is more limy and less friable than it is above; below a depth of 46 inches, it grades to highly calcareous, silty, wind-deposited material.

The parent material of the Ulysses soils is silty, medium-textured, wind-deposited material. The native short grasses under which these soils formed consist mostly of blue grama, little bluestem, switchgrass, side-oats grama, and western wheatgrass.

The Ulysses soils occur with the Richfield and Pullman soils and have a less clayey and more friable subsoil than those soils. Their grit-free, medium-textured parent material distinguishes them from the Mansic soils. Ulysses soils are less sandy and more silty than the Dalhart soils.

Typical profile of a Ulysses silt loam in a cultivated field (east of a road and about 1,332 feet north and 50 feet east of the southwest corner of SW¼ sec. 22, T. 1 N., R. 22 E.):

A_1 0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; upper 4 inches disturbed by cultivation; lower 2 inches has strong, medium, granular structure; soft when dry, friable when moist; noncalcareous; clear boundary.

B_2 6 to 15 inches, dark-brown (7.5YR 4/2) light silty clay loam, dark brown (7.5YR 3/2) when moist; coarse, prismatic and strong, granular compound structure; slightly hard when dry, friable when moist; many worm casts; weakly calcareous; grades through a transition of about 6 inches to horizon below.

C_{ca} 15 to 46 inches, reddish-yellow (7.5YR 6/6) light silty clay loam, strong brown (7.5YR 5/6) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; calcareous; soft concretions of lime as much as one-fourth inch in diameter makes up about 1 percent of horizon; worm casts numerous but fewer than in B_2 horizon;

porous; moderately numerous roots and root channels; clear boundary.

C 46 to 60 inches, reddish-yellow (7.5YR 7/6) silt loam, reddish yellow (7.5YR 6/6) when moist; massive (structureless); soft when dry, friable when moist; porous; strongly calcareous.

When dry, the surface layer of the Ulysses soils ranges from dark grayish brown (10YR 4/2) to grayish brown or brown in color and from 6 to 14 inches in thickness. It is darker colored under native pasture. In some cultivated fields these soils are calcareous, but under native pasture, they are noncalcareous to a depth of 5 to 14 inches. In this county, the texture of the surface layer is mostly silt loam, but where the Ulysses soils are associated with the Dalhart soils, the texture is loam.

In some places, the B horizon has not formed, but where it does occur, its structure is generally subangular blocky. Where the B horizon is absent, an AC horizon occurs, and it has a strong, coarse, prismatic to a medium and fine, granular structure. When dry, the subsoil ranges from dark grayish brown (10YR 4/2) to strong brown (7.5YR 5/6). In some places, the C horizon has a slightly reddish (7.5YR) hue.

Ulysses soils are permeable to air and water. Their available moisture-holding capacity ranges from moderate to high, depending on the content of clay and organic matter. Surface runoff is slow to moderately rapid. Erosion is slight except in the more rolling areas, where it is moderate.

Ulysses silt loam, 0 to 1 percent slopes (UsA) formed in deposits of silt. It is in the northern part of the county on smooth, nearly level slopes in the valleys east of Forgan and Gate. It is friable, permeable, and well suited to crops. The surface layer is about 12 inches thick, but otherwise the profile is like the one described for the series. Included with this soil are small areas of Richfield, Randall, and Dalhart soils.

Ulysses silt loam, 0 to 1 percent slopes, occurs in rather large areas, but its total acreage in this county is not large. Nearly all of it is cultivated and planted to dry-farmed wheat and grain sorghum. This soil is well suited to irrigation, and yields of irrigated alfalfa are excellent. A scarcity of moisture and a slight susceptibility to wind and water erosion are the main problems of management. Most cultivated fields are slightly eroded, and a tillage pan may form if plowing is not properly done. Conservation practices are easy to apply, however, and this soil can be kept productive. (Capability unit IIIc-1; Loamy Prairie range site)

Ulysses silt loam, 1 to 3 percent slopes (UsB) is in broad, gently undulating areas in the southwestern, northwestern, and northeastern parts of Beaver County. This soil is on smooth, convex slopes between the drainageways in the High Plains; it is in areas between the more level Richfield soils and the more sloping Ulysses soils. Generally, it is more developed than the Ulysses soils that are nearby on steeper slopes. Included with this soil are small areas of the Richfield soils and of the limy Mansker soils.

This soil is very friable and permeable. Though profiles are fairly uniform, some contain more clay than others. This soil has a good supply of plant nutrients, is productive, and responds well to management. Most of it is in grain sorghum and small grain. Wheat yields are excellent where moisture is adequate.

Cultivated fields need rather intensive management because the surface layer of this soil is ashy and is moderately susceptible to wind erosion. The hazard of water erosion is slight in most places, but sheet erosion has been active in a few moderately eroded places. Productivity is easy to maintain on this soil, however, by the use of suitable cropping systems and intensive measures to control wind and water erosion. (Capability unit IIIe-1; Loamy Prairie range site)

Ulysses silt loam, 3 to 5 percent slopes (UsC) is extensive along the draws or drainageways in the High Plains, mainly in the southwestern part of Beaver County. Small areas are on the rim of the tableland that surrounds Knowles and Gate in the northeastern part of the county.

Included with this soil are small areas of limy Mansker soils, of Potter soils, and of Richfield soils. The Potter soils are near the breaks of the valleys, and the Richfield soils are in small, concave areas at the base of the long slopes.

Because of erosion, the surface layer of this soil is not so deep as that of the less sloping Ulysses soils. When dry, this layer is loose and ashy and is highly susceptible to wind erosion. The subsoil is weakly developed, is very friable, is of granular structure, and is permeable to water, air, and roots.

About 70 percent of this soil is in crops; pasture is best suited, but cultivated crops can be grown if management is intensive. Winter wheat is the main crop, but sorghum yields are good where moisture is adequate.

Erosion is the main problem in farming this soil, and though erosion is mostly slight, light-colored, moderately eroded spots are common. The slopes are susceptible to washing, and barren fields blow severely, especially during droughts. If this soil is allowed to erode, fertility gradually declines, tillage is difficult, and the soil is more susceptible to further erosion. To control erosion and maintain fertility, provide contour cultivation, terraces, proper management of residue, well-grassed waterways, and stubble-mulch tillage. (Capability unit IVe-1; Loamy Prairie range site)

Ulysses-Richfield complex (0 to 3 percent slopes) (Ur) is in broad areas of low, rounded knolls and ridges that rise above the level plains. Most of it is in the southern part of Beaver County, but a small part is near Knowles and Gate in the northeastern part. The Ulysses soils are on low, oval-shaped hills. They are lighter colored than the Richfield soils and contains much lime. They have a silty surface layer that overlies a granular, friable subsoil. The Richfield soils have a more clayey subsoil than the Ulysses soils. They are in small, valleylike depressions and on intervening flats. Turn to the Ulysses series and the Richfield series for descriptions of profiles representative of the soils in this complex.

Ulysses-Richfield complex is productive and is almost entirely in cultivated crops. Yields of wheat are good in favorable seasons, and other small grains and sorghum do well where moisture is adequate.

Productivity is easy to maintain on this complex if good farming is practiced, but the soils are not suited to terracing or contour cultivation. The ashy surface layer on the low hills occupied by the Ulysses soils of the complex is moderately susceptible to wind erosion, which has already slightly thinned the surface layer in places. Good management of residue protects this complex from blowing

and maintains the content of organic matter. (Capability unit IIIe-1; Hardland range site)

Vernon Series

The Vernon series consists of shallow, reddish soils on the prairie. These soils are along the breaks of valleys, mostly in the southern part of Beaver County. Their surface layer, about 8 inches thick, is reddish-brown clay loam. This is underlain by a red layer of partly weathered clay and shale that contains small concretions of lime. Below a depth of 27 inches is hard, unweathered shale of the red beds.

The parent material of these soils is weathered shale, siltstone, sandstone, and clay of the Permian red beds. In Beaver County, exposures of these red beds are mainly along the main streams and in the valleys. The Vernon soils formed under native prairie grasses, mostly side-oats grama, little bluestem, and blue grama.

Vernon soils occur mainly with the Woodward, Mansic, and Carey soils, which are more developed and deeper than the Vernon.

Only one soil in the Vernon series was mapped in this county.

Typical profile of a Vernon soil in native pasture (south of the highway and 316 feet west and 792 feet south of the northeast corner of NW¼ sec. 30, T. 2 N., R. 20 E.):

A 0 to 8 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; calcareous; clear boundary.

C 8 to 27 inches, red (2.5YR 5/6), partly weathered shale and clay, weak red (2.5YR 4/6) when moist; massive (structureless); concretions of lime make up about 1 percent of the horizon; strongly calcareous; clear boundary.

D 27 to 42 inches, red (2.5YR 4/6), unweathered shale from Permian red beds, dark red (2.5YR 3/6) when moist.

The Vernon soils vary mainly in their depth to unweathered material. In some places this material is exposed on the surface, and in others it is at a depth of 4 feet. Though the texture of the surface layer is mostly clay loam, in some places it is loam and silt loam. In areas where sandstone is at the surface, the texture is almost fine sandy loam. These soils are slightly calcareous to strongly calcareous and, in places, contain concretions of lime in the lower horizons. Quartziferous pebbles are on the surface and in the upper part of the profile; generally they are numerous on the crest of slopes.

Vernon loams (3 to 10+ percent slopes) (Ve) is in one broad area of pasture, along the southwestern boundary of the county. In this area, which extends across several square miles, are dissected breaks or escarpments of red, shaly clay. Included with Vernon loams are small areas of Woodward, Mansic, and Carey soils.

Vernon loams are slowly permeable, and water cannot penetrate the impervious shale and clay in their substratum. The amount of water lost through runoff, therefore, is high. In areas of scanty vegetation, rapid runoff causes severe erosion.

Because of their shallow depth, strong slopes, and susceptibility to erosion, Vernon soils are not cultivated. Pasture is the most economical use, but even when management is good, suitable forage is difficult to maintain. The grasses best suited are mainly side-oats grama, blue grama, and little bluestem. Heavily grazed areas are infested by annual grasses, hairy tridens, and three-awn. Prevention of overgrazing and other good grazing practices will help to increase yields of forage and impede rapid runoff and further erosion. (Capability unit VIIs-1; Shallow range site)

Woodward Series

The Woodward series consists of friable, loamy soils. In Beaver County, these soils are mostly on the valley slopes on the south side of the Beaver River, but small areas are north of the river and along the Cimarron River.

The surface layer of these soils is brown loam, about 7 inches thick. It is friable, of a granular structure, and is easy to till. The underlying subsoil material is reddish-yellow, friable loam. When moist, this layer breaks into large prisms that crumble easily to medium-sized granules. The subsoil is porous and permeable to air and water. Below a depth of 18 inches is loamy, strongly calcareous material that grades to unweathered red beds at about 43 inches. If cultivated, Woodward soils are generally calcareous at the surface and are more calcareous in the lower part of the profile. Their parent material is weathered siltstone, sandstone, and shale from the red beds.

The Woodward soils occur with Vernon, Carey, and Mansic soils. They are less clayey and deeper than the Vernon soils. They do not have a textural B horizon, as do the Carey soils, and they are less deep to lime. Woodward soils are more red and contain less clay than the Mansic soils. In this county, however, they are so closely associated with Mansic soils that they are mapped only in a complex with them.

Typical profile of a Woodward soil (south of a road and about 150 feet west and 384 feet south of the northeast corner of NW¼ sec. 3, T. 3 N., R. 22 E.):

A_{1p} 0 to 7 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak structure to almost massive (structureless) in upper 4-inch, or plowed, layer, and strong, medium, granular structure in lower 3 inches of undisturbed soil; slightly hard when dry, friable when moist; calcareous; clear boundary.

AC 7 to 18 inches, reddish-yellow (5YR 6/6) loam, yellowish red when moist; weak, coarse, prismatic and moderate, medium, granular structure; slightly hard when dry, friable when moist; very porous; contains medium sand and small amount of pebbles as large as 1 inch in diameter; many casts; strongly calcareous; gradual boundary.

C_{ca} 18 to 37 inches, reddish-yellow (5YR 6/6) loam, yellowish red (5YR 5/6) when moist; massive (structureless); slightly hard when dry, very friable when moist; very porous; appreciable amount of coarse sand; strongly calcareous, with few concretions of calcium carbonate; gradual boundary.

D 37 to 43 inches, red (2.5YR 4/6), unweathered red-bed shale; dark red (2.5YR 3/6) when moist; massive (structureless).

In some places a thin mantle of alluvial material has washed onto the Woodward soils from the bordering slopes. In most places the surface layer is 6 to 10 inches thick. It is mostly loam, but it is silt loam or fine sandy loam in a few places. The A horizon ranges from brown to reddish brown. Most of these soils are calcareous throughout, but the depth to free carbonates may be as much as 12 inches.

At the top of slopes, these soils include small areas of Mansker soils and of gravelly material that resembles the Potter soils.

Woodward-Mansic complex (Wm) occurs along the breaks of valleys where many drainageways have cut into the Permian red beds. Thin strips of outwash material from the plains form a blanket on the narrow divides occupied by the mapping unit. Though most of this complex in Beaver County is on the slopes south of the Beaver River, small parts are on the slopes north of the river and on both sides of the Cimarron River.

Generally, the Mansic soils are on the divides and the strong slopes; the Woodward soils are in exposures of reddish earth along the drains and on gentle slopes. Much overwash is in the broken channels.

About 20 to 50 percent of this complex consists of Woodward soils; 15 to 45 percent, Mansic soils; 8 to 12 percent, Vernon soils; 8 to 10 percent, Spur soils; 5 to 15 percent, Otero, Mansker, and Potter soils; and less than 20 percent, Bippus soils. The steeply sloping Vernon soils occupy the breaks of the drains, and the Spur soils are in the narrow bottoms. The Otero soils, which formed in remnants of coarse-textured outwash sediments, normally occur at the base of the mantle of Tertiary outwash. The Potter and the Mansker soils are in a narrow band between the top of the red beds and the breaks of the valleys. The Bippus soils are in pockets of colluvial and alluvial deposits in small, concave areas.

Many of the soils in this complex are more gravelly, especially near the surface, than they are in areas where they are mapped separately in Beaver County. The Potter and Otero soils are especially gravelly. Though this mapping unit ranges from gently sloping to steep, most of it is moderately sloping. The terrain is eroded and is broken by abrupt, narrow drainage channels. Along the drains there are severely eroded, bare spots, but more than 85 percent of the complex contains vegetation, mostly of blue grama, buffalograss, side-oats grama, and a small amount of yucca. All of this mapping unit is in range. (Capability unit VIe-3; Mixed Hardland and Shallow range site)

Use and Management of Soils

This section explains how soils are grouped according to their capability and discusses the management of the capability units in Beaver County. It also discusses the hazard of erosion in the county and describes specific management practices and permanent conservation structures. In a table, yields of wheat and grain sorghum on dry-farmed soils are estimated.

Capability Groups of Soils

The capability classification is a grouping that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on the limitations of the soils, the risk of damage when they are used, and the way they respond to management.

In this system all the kinds of soils are grouped at three levels, the capability class, subclass, and unit. Eight capability classes are in the broadest grouping and are designated by Roman numerals I through VIII. In class I are soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, grazing, or wood products.

The subclasses indicate the major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIIe. The letter *e* shows that the main limitation is risk of erosion unless a cover of close-growing plants is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no erosion hazard but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, which are groups of soils enough alike to be suited to the same pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIc-2 or IIIe-2. The soils in each unit have about the same hazards and limitations of use and require about the same management.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of permanent limitations. Not considered in this classification are major and generally expensive landforming or reclamation that would change the slope, depth, or other characteristics of the soil.

The soils of Beaver County have been grouped in the following capability classes, subclasses, and units. No soil in this county is in class I.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

- Subclass IIc.—Soils that are slightly limited for crops by insufficient effective rainfall.
  - Unit IIc-1.—Deep, dark, nearly level, moderately permeable, hardland soil.
  - Unit IIc-2.—Deep, dark to moderately dark, well-drained soils of the bottom lands.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

- Subclass IIIe.—Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe-1.—Deep to moderately deep, gently sloping, hardland soils.

Unit IIIe-2.—Deep, nearly level to gently undulating, sandy soils on uplands.

Subclass IIIc.—Soils that are severely limited for crops by insufficient effective rainfall.

Unit IIIc-1.—Deep, nearly level, slowly to moderately permeable, hardland soils.

Class IV. Soils that have very severe limitations that restrict the choice of plants, or require very careful management, or both.

Subclass IVe.—Soils subject to very severe erosion if they are cultivated and not protected.

Unit IVe-1.—Deep to moderately deep, sloping, hardland soils.

Unit IVe-2.—Deep, undulating, moderately sandy to sandy soils on uplands.

Class V. Soils that have limitations, other than erosion hazard, that are impractical to remove and that limit their use largely to pasture, range, or wildlife cover.

Subclass Vw.—Soils subject to poor drainage or flooding.

Unit Vw-1.—Stiff, clayey soils in playas or enclosed depressions; subject to occasional overflow.

Unit Vw-2.—Soils on bottom lands that have a high water table.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe.—Soils severely limited, chiefly by risk of erosion, if protective cover is not maintained.

Unit VIe-1.—Sandy soils along the rivers and creeks.

Unit VIe-2.—Shallow, limy, severely eroded soils.

Unit VIe-3.—Shallow to moderately deep, hardland soils that have caliche or rock at or near the surface.

Unit VIe-4.—Sandy or loamy soils that are limy.

Unit VIe-5.—Shallow to deep, sloping to moderately steep, sandy soils.

Unit VIe-6.—Deep, sandy soils that occur on foot slopes or have duny relief.

Class VII. Soils that have very severe limitations that make them generally unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland, and wildlife.

Subclass VIIe.—Soils very severely limited, chiefly by risk of erosion, if protective cover is not maintained.

Unit VIIe-1.—Deep, light-colored, extremely sandy soil with duny relief.

Subclass VIIs.—Soils very severely limited by moisture capacity, stones, or other soil features.

Unit VIIs-1.—Shallow, hardland soils that have siltstone and clay beds at or near the surface.

Class VIII. Soils and landforms having limitations that prevent their use for commercial production of plants and that restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIe.—Extremely erodible land.

Unit VIIIe-1.—Active sand dunes.

Management of capability units

The soils of Beaver County have been placed in 18 capability units. The soils in one unit have about the same limitations, need essentially the same management, and respond to management in about the same way. Additional information about the management of each soil is furnished in the section "Descriptions of Soils."

CAPABILITY UNIT IIc-1

Carey silt loam, 0 to 1 percent slopes, is the only soil in this capability unit. It is a deep, nearly level, silty soil that is fertile and easy to work. The subsoil is silty clay loam that is ganular, permeable, and high in available water-holding capacity. This productive soil requires only moderate practices to conserve moisture, but crops are likely to be damaged in summer by drought when rainfall is below average. Most of this soil is in the eastern part of the county where rainfall is a little more favorable than it is in the western part.

This soil is suited to all crops commonly grown in the county under dryland farming. Wheat is the principal crop. Low yields of wheat can be expected if, at planting time, soil moisture does not extend to a depth of at least 20 inches.

Conserve moisture by managing crop residue well and by farming on the contour. Terraces may be needed on long, gentle slopes of more than one-half percent. Where they are needed, use diversion terraces to protect the soils against runoff from higher lying areas. Contour stripcropping will aid in controlling wind erosion and the loss of water through runoff. Vary the depth of tillage so that a plowpan does not form. Where they have formed, these pans may be broken by chiseling or by subsoiling.

CAPABILITY UNIT IIc-2

This unit contains deep, dark to moderately dark, loamy to moderately sandy soils on bottom lands. These soils are on smooth, nearly level, low benches above ordinary overflow. They are well drained, high in available water-holding capacity, productive, and easily worked. The soils in this unit are:

Canadian fine sandy loam.
Spur soils.

These soils are suited to wheat, grain sorghum, forage sorghum, and sudangrass. Wheat is the main crop. During years when moisture is favorable, alfalfa can be grown with some success under dryland farming. Many fields produce excellent yields under irrigation. If at planting time soil moisture does not extend to a depth of at least 22 inches, wheat yields are generally low. Well suited to pasture or grassed waterways are side-oats grama, blue grama, switchgrass, sand bluestem, little bluestem, western wheatgrass, and other native grasses.

The main problems of management are conserving moisture, controlling erosion and deterioration of the structure of the surface soil, and preventing flooding by runoff or overflow water. Management ought to include stubble mulching, constructing terraces to divert water from adjacent slopes, stripcropping, and use of cropping systems suited to moisture conditions. On soils not protected by a growing crop or sufficient stubble, emergency

tillage may be needed to control blowing in spring. Avoid excessive tillage that pulverizes the surface and makes it blow more easily. Vary the depth of tillage so that a tillage pan does not form. Where they have formed, these pans can be broken by deep chiseling or by subsoiling.

CAPABILITY UNIT IIIe-1

This unit contains deep to moderately deep, hardland soils on gentle upland slopes. These soils have a loamy surface soil and a clayey subsoil with moderately high available water-holding capacity. They are productive soils, but they need intensive practices to conserve moisture and to control wind and water erosion. These soils are:

- Bippus clay loam, 1 to 3 percent slopes.
- Carey silt loam, 1 to 3 percent slopes.
- Mansic-Woodward complex, 1 to 3 percent slopes.
- Mansic clay loam, 1 to 3 percent slopes.
- Mansker clay loam, 1 to 3 percent slopes.
- Richfield clay loam, 1 to 3 percent slopes.
- Ulysses silt loam, 1 to 3 percent slopes.
- Ulysses-Richfield complex.

These soils are suited to wheat, grain sorghum, forage sorghum, and sudangrass. Wheat is the principal crop. If at planting time soil moisture does not extend to a depth of at least 22 inches, wheat yields are generally low. Well suited to pasture or grassed waterways are western wheatgrass, side-oats grama, blue grama, switchgrass, and little bluestem.

Conserving moisture and controlling erosion are the main problems of management. Practices include stubble mulching, stripcropping, contour farming, and terracing. On soils not protected by a growing crop or sufficient stubble, emergency tillage may be needed to control blowing in spring. Avoid excessive tillage that pulverizes the surface soil and makes it blow more easily. Vary the depth of tillage so that tillage pans do not form. Where they have developed, these pans can be broken by deep chiseling or by subsoiling.

CAPABILITY UNIT IIIe-2

This unit contains deep, sandy soils on smooth, nearly level to gently undulating upland plains. These soils have a fine sandy loam surface soil and a subsoil of sandy clay loam that has a moderate to high available water-holding capacity. They are productive soils, but intensive management is needed to conserve moisture and control wind and water erosion. The soils in this unit are:

- Dalhart fine sandy loam, 0 to 1 percent slopes.
- Dalhart fine sandy loam, 1 to 3 percent slopes.

These soils are suited to grain sorghum, forage sorghum, wheat, and sudangrass. Grain sorghum is the main crop. Native grasses are well suited to pasture and grassed waterways. These grasses include sand bluestem, little bluestem, switchgrass, side-oats grama, sand lovegrass, western wheatgrass, and blue grama.

Conserving moisture, maintaining organic matter, and controlling wind erosion are the main problems of management (fig. 14). Management practices include stubble mulching, use of cropping systems suited to moisture conditions, stripcropping, building terraces that pond water, and contour farming. Fallow is beneficial in dry periods. On soils not protected by a growing crop or sufficient stubble, emergency tillage may be needed to control blowing in spring. Avoid excessive tillage that pulverizes the surface soil and makes it blow more easily. Vary the depth of tillage so that a tillage pan does not form. Where they have formed, these pans can be broken up by deep chiseling or by subsoiling.

Figure 14.—**Stubble of grain sorghum traps blowing soil during a duststorm.**

CAPABILITY UNIT IIIc-1

This unit consists of deep, dark-colored, hardland soils on smooth, nearly level upland slopes. These soils have a loamy surface soil and a subsoil that is clayey and has a moderately high available water-holding capacity. They are productive soils and require only easily applied practices to conserve moisture and to control wind and water erosion. The soils in this unit are:

- Pullman clay loam.
- Richfield clay loam, 0 to 1 percent slopes.
- Richfield loam, thick surface.
- Ulysses silt loam, 0 to 1 percent slopes.

These soils are suited to wheat, grain sorghum, forage sorghum, and sudangrass. Wheat is the principal crop. If at planting time soil moisture does not extend to a depth of at least 22 inches, wheat yields are generally low. Side-oats grama, blue grama, western wheatgrass, and other native grasses are well suited to pasture and grassed waterways.

Conserving moisture, controlling erosion, and checking deterioration of the structure of the surface soil are the main management problems. Management practices include stubble mulching, stripcropping, use of cropping systems suited to moisture conditions, terracing that impounds water, and contour farming. Fallow is beneficial in dry periods. On soils not protected by a growing crop or sufficient stubble, emergency tillage may be needed to control blowing in spring. Avoid excessive tillage that pulverizes the surface and makes it blow easily. Vary the depth of tillage so that a tillage pan does not form. Where they have formed, these pans can be broken by deep chiseling or by subsoiling.

CAPABILITY UNIT IVe-1

This unit contains deep to moderately deep, hardland soils on moderately sloping uplands. The soils have a loamy surface soil and a clayey subsoil with a moderately

high available water-holding capacity. Runoff is moderate to rapid. These soils are suited to cultivation and are moderately productive. To maintain their fertility under dryland farming, however, intensive practices are needed to control wind and water erosion. The soils in this unit are:

Mansic clay loam, 3 to 5 percent slopes, eroded.
Mansic-Woodward complex, 3 to 5 percent slopes, eroded.
Mansker clay loam, 3 to 5 percent slopes.
Richfield-Mansic clay loams, 3 to 5 percent slopes.
Ulysses silt loam, 3 to 5 percent slopes.

These soils are best suited to pasture, but if managed intensively, they can be cultivated. Suitable crops are wheat, grain sorghum, forage sorghum, and sudangrass. Wheat is the principal crop. Well suited to pasture and grassed waterways are western wheatgrass, side-oats grama, blue grama, switchgrass, little bluestem, and other native grasses.

Conserving moisture, maintaining soil fertility, and controlling erosion are the main problems of management. Suitable practices are terracing, contour farming, contour stripcropping, stubble mulching, and providing cropping systems suited to moisture conditions. Fallow, including delayed fallow, is desirable in dry periods. Construct and vegetate waterways where needed. On soils not protected by a growing crop or sufficient stubble, emergency tillage may be needed to control erosion. Avoid excessive tillage that would pulverize the surface soil and make it blow more easily. Vary the depth of tillage so that a tillage pan does not form. Where they have formed, these pans can be broken by deep chiseling or subsoiling.

CAPABILITY UNIT IVe-2

This unit contains deep, moderately sandy to sandy soils on gentle to moderate slopes on undulating uplands. These soils soak up water rapidly, but they have a moderate to low storage capacity. They are highly susceptible to wind erosion but are productive under suitable management. These soils are:

Mansic-Otero complex, 1 to 3 percent slopes.
Pratt fine sandy loam, undulating.
Pratt loamy fine sand.

These soils are more easily managed in grass than in crops. They are, however, suited to grain sorghum, forage sorghum, wheat, and sudangrass. Grain sorghum is the principal crop. Native grasses are well suited for pasture and grassed waterways. Such grasses are sand bluestem, little bluestem, switchgrass, side-oats grama, western wheatgrass, and Canada wildrye.

Conserving moisture and controlling wind erosion are the main problems of management. Suitable practices are management of crop residue, stubble mulching, wind stripping, and using a cropping system suited to moisture conditions. Use perennial grasses in the cropping system. On soils not protected by a growing crop or sufficient stubble, emergency tillage may be needed to control wind erosion. Avoid excessive tillage that pulverizes the surface soil and makes it blow more easily. Vary the depth of tillage so that a tillage pan does not form. Where they have formed, these pans can be broken by deep chiseling or by subsoiling.

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CAPABILITY UNIT Vw-1

Randall clay is the only soil in this capability unit. It is stiff and compact. This soil is in enclosed depressions or playas that are scattered in the upland plains. It has little internal drainage, and water collects and stands on it until removed by evaporation. This soil swells when wet, and shrinks and forms large cracks when dry. It is droughty in prolonged dry periods and in wet periods is covered with water that drowns all vegetation.

This soil is best suited to permanent vegetation. Since it is in natural depressions and receives runoff water from adjacent slopes, the control of this water reduces the amount of water that stands on this soil. Turn to "Hardland Range Site" for a discussion of range management on Randall clay.

CAPABILITY UNIT Vw-2

This unit consists of only Las Animas soils, which are subirrigated soils on bottom lands. These soils are loamy to moderately sandy. They have a high water table and tend to be saline. The soils occupy nearly level to gently sloping flood plains of major creeks and rivers. Because of the high water table, they are not well suited to cultivation. Under good management, however, they produce excellent grass and meadow.

These soils produce high yields of grasses that are suited to wet soils. Areas that are well managed produce the more palatable grasses, but less desirable grasses and annuals invade the overgrazed areas. Trees can be planted on these soils. Turn to "Subirrigated Range Site" for a discussion of range management on Las Animas soils.

CAPABILITY UNIT VIe-1

Lincoln soils are the only soils in this capability unit. These are sandy soils on bottom lands on the low flood plains of creeks and large upland streams. The soils consist of deep, sandy alluvium and are subject to flooding and recurrent deposition. When the streams are in normal flow or are dry, these soils are droughty and shift and blow with the wind.

Because they are droughty and subject to wind erosion and flooding, these soils are best suited to permanent pasture. They are also suitable for planting trees. Turn to "Sandy Bottom Land Range Site" for a discussion of range management on Lincoln soils.

CAPABILITY UNIT VIe-2

Mansic soils, severely eroded, are the only soils in this capability unit. These soils are shallow to moderately shallow, and they have a low capacity for storing moisture. They are limy, infertile, and susceptible to further erosion if left bare.

These soils have been so severely eroded that they are no longer productive as cropland and are best suited to pasture. Suitable native grasses for pasture and waterways are side-oats grama, blue grama, switchgrass, sand bluestem, and little bluestem. Turn to "Shallow Range Site" for a discussion of range management on Mansic soils, severely eroded.

CAPABILITY UNIT VIe-3

In this unit are shallow to moderately deep, hardland soils on moderate to steep upland slopes and in drainageways. The surface layer of these soils varies in depth

but is shallow and is underlain by caliche or other raw earth. If management is neglected, runoff and erosion are severe hazards. The soils in this unit are:

Alluvial and broken land.
Mansker-Potter complex.
Woodward-Mansic complex.

These soils are in permanent pasture. They are not suited to cultivation. Fair yields of forage can be obtained if management is good. Turn to "Mixed Hardland and Shallow Range Site" for a discussion of range management on the soils in this capability unit.

CAPABILITY UNIT VIe-4

This unit consists of loamy to moderately sandy, limy soils that are gently undulating to undulating. These soils are:

Otero soils, 3 to 5 percent slopes, eroded.
Otero-Mansker complex.

Some areas of these soils have been cultivated and have lost much of their fertility through erosion. The soils are best suited to permanent vegetation. Native grasses suitable for revegetation or overseeding are little bluestem, switchgrass, sand bluestem, and side-oats grama. Good yields of forage can be obtained from native pasture if management is good. Turn to "Limy Sandy Plains Range Site" for a discussion of range management on the soils in this capability unit.

CAPABILITY UNIT VIe-5

Otero-Pratt fine sandy loams, 3 to 12 percent slopes, are the only soils in this capability unit. These soils vary in depth, texture, and slope. Most of the acreage is fine sandy loam, but some loamy fine sand is included, and narrow bands of limy and shallow caliche soils are intermingled with these soils in many places. These bands are of heavier, more clayey materials.

The soils of this unit are best suited to permanent pasture. Excellent yields of forage are obtained where management is good. Sand sagebrush and other less desirable grasses commonly invade heavily grazed areas. Turn to "Sandy Plains Range Site" for a discussion of range management on Otero-Pratt fine sandy loams, 3 to 12 percent slopes.

CAPABILITY UNIT VIe-6

This unit contains deep, sandy soils that are on undulating dunes or on gently sloping, concave foot slopes in the uplands. These soils are droughty and susceptible to severe wind erosion. They are:

Likes loamy fine sand.
Pratt-Tivoli loamy fine sands.

These soils are best suited to pasture. Normally they support tall grasses, but where heavily grazed, they are commonly invaded by sand sagebrush. Turn to "Deep Sand Range Site" for a discussion of range management on these soils.

CAPABILITY UNIT VIIe-1

Tivoli fine sand is the only soil in this capability unit. This soil is deep, coarse, and loose and is on high dunes that are only partly stabilized. It is droughty and relatively low in productivity.

This soil should be kept in permanent vegetation. It is best suited as wildlife habitats. It has many limitations when used for pasture. Sand sagebrush and skunkbrush are common. Turn to "Dune Range Site" for a discussion of range management on Tivoli fine sand.

CAPABILITY UNIT VIIs-1

Vernon loams are the only soils in this capability unit. These soils are gently sloping to steep, shallow, and droughty. They have a thin, loamy or clayey surface soil that is underlain by siltstone or beds of clay.

These soils are suited only to permanent vegetation. They are susceptible to severe erosion unless a good cover is maintained. Under good management, however, yields of forage are fair. Turn to "Shallow Range Site" for a discussion of range management on Vernon loams.

CAPABILITY UNIT VIIIe-1

This unit consists of only Active dunes, which are sand dunes more than 20 acres in size. These dunes are barren or support only scattered stands of tall grasses. Consequently, they are free to shift and blow with the wind. They produce little useful vegetation but may have some value for wildlife.

Hazards of Erosion

Water erosion and wind erosion have damaged the soils of Beaver County. Part of the surface layer has been removed in many fields, and in some places this layer has been completely removed and the raw, limy subsoil is exposed. The wind has blown away the fine particles of many cultivated sandy soils, and coarse, infertile particles of sand now make up most of the surface layer. Blowouts and sandy hummocks are common in many severely damaged areas. Along many fence rows are piles of soil, as much as 5 feet deep, that have been deposited by the wind. Though most of the damage was done in the mid 1930's, much soil still drifts in the county during windy periods.

In planning erosion control, the climate, crops to be grown, and the soils should be considered. The farmer must be prepared for changes in his cropping and management because the climate of Beaver County is unpredictable. He should farm with the purpose of keeping as much cover on the soil for as long as is practical. Drought reduces vegetation and the protection of the soil, but drought alone does not cause erosion. The farmer needs to be prepared for periods of low precipitation and high wind, and also for rainy periods when the soil is likely to wash away.

Practices that increase wind and water erosion should be avoided. If fields are tilled too much, the soil is pulverized and is more likely to blow. Also, pulverized soil washes away readily in heavy rains. Overgrazed pasture, particularly on sandy soils, is susceptible to severe erosion.

The best defense against erosion is a good cover of vegetation. A protected soil absorbs water, and the good structure of this soil transmits the water freely. In wet periods the soil may become saturated and may require grassed waterways to carry away runoff. It may also require structures such as terraces. Crop residue should be managed to help prevent wind erosion. A roughened surface will slow down the wind at the surface and trap drifting soils. Erosion can be reduced by crop strips, ridges, shelterbelts, and other barriers that trap drifting soil and keep it from spreading.

Use and Management of Cultivated Soils[1]

The problems of use and management are the same for the cultivated soils of Beaver County as for those of adjacent areas in the southern Great Plains. These problems center around the protection of the soils from wind erosion, the conservation of moisture, and the production and management of protective amounts of crop residue. Erratic rainfall and highly erosive winds complicate the problems, for droughts and extreme fluctuations in rainfall are common. A single rain may account for 20 percent or more of the rain that falls in a year. The effectiveness of the rainfall is further reduced by a high evaporation.

Successful management provides crops that produce large amounts of crop residue to protect the soil and to replace the organic material that the crops have used. A supply of organic matter will improve tilth, air circulation, and the capacity to store moisture.

The management needed in Beaver County to control erosion generally consists of a combination of practices. This combination varies with the kind of soil, the topography, the climate, and the type of farming. It may consist of one or more of the following: Stubble mulching, use of crop residue, use of cover crops, establishment of perennial vegetation, summer fallow, range seeding, stripcropping, terracing, grassing waterways, contour tillage, and emergency tillage to control wind erosion.

Use of crop residue

Crop residue is used by leaving it on the surface of cultivated fields during times when erosion is generally critical, and by plowing it into the soil so that the supply of organic matter is maintained. Crop residue can be used in all cultivated fields where stubble mulching is not required (fig. 15).

The crop residue (1) furnishes a regular supply of organic material to the soil and thereby improves the surface soil so that infiltration and moisture storage are increased and surface crusting is reduced, and (2) provides seasonal protection for the soil from wind and water erosion.

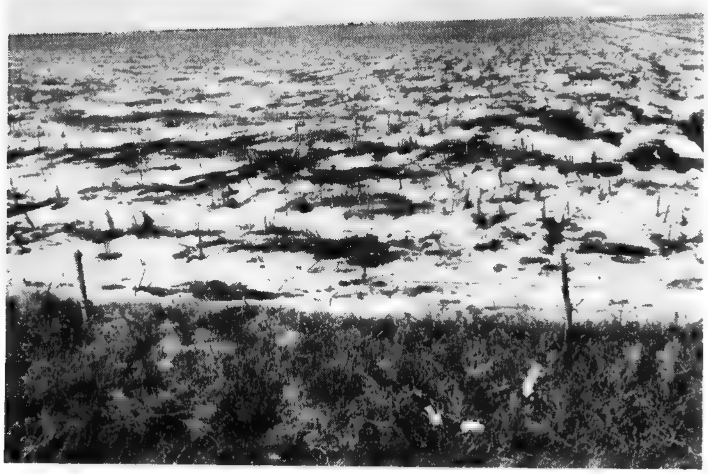

Figure 15.—**Stubble from grain sorghum protects the soil surface from wind and water erosion. It also helps hold the snow on the field while it melts and soaks into the soil to be taken in by crops.**

Figure 16.—**Wheat planted in stubble with a drill capable of seeding in heavy residue. The residue prevents soil blowing until the crop makes enough growth to protect the soil.**

Crop residue is especially important on sandy soils in winter and early in spring when the erosion hazard is critical. Grazing or other uses of crop residue should be limited so that enough residue is left on the surface to protect the soil. The amount of residue needed to protect different kinds of soil from wind erosion is discussed in the subsection "Stubble mulching."

Stubble mulching

On a stubble-mulched field, all plowing, planting, cultivating, and harvesting are performed so that protective amounts of residue from the preceding crop remain on the surface at seeding time. Some use is made of such tillage implements as sweeps, rod weeders, and blades that undercut and leave the crop residue on the surface and anchor it (fig. 16).

Stubble mulching has not been widespread in the county, but it is gaining acceptance. After harvest many farmers now use chisels and sweeps for controlling weeds and preparing a seedbed. This method usually leaves protective amounts of stubble on the surface at seeding time. Sometimes, however, this stubble is worked into the surface soil at seeding time, and the benefits of stubble mulching are lost. Wind erosion is most likely from the time small grain is seeded in fall until it has made sufficient growth to protect the soil.

Stubble mulching is beneficial on all soils, especially where small grains are seeded. It (1) improves the soil by increasing water infiltration and improving tilth, (2) tends to check the decrease in organic matter, (3) reduces the extremes of temperature in the surface soil, (4) protects the surface soil from wind erosion and water erosion, and (5) reduces the loss of water.

The speed of wind, the kind of soil, the physical condition of the soil, and other factors determine how susceptible a field is to wind erosion, and how much residue is required for protection. If seeding is broadcast, more residue is needed on sandy soils than on clayey soils.

[1] This subsection was written by M. D. GAMBLE, agronomist, Soil Conservation Service.

The residue left by row crops planted in rows of average width is double the amount left by broadcast crops. Generally, about 100 pounds of straw is produced per acre for each bushel of wheat, and 200 pounds of residue is produced for each bushel of grain by grain sorghum in rows of average width.

Equipment used in stubble mulching is designed to undercut the stubble and leave it anchored on the surface at seeding time. This equipment should (1) be capable of operation at a controlled and uniform depth; (2) be equipped with rolling colters before each shank so that clogging is prevented by the cutting of residue and weeds ahead of sweeps; (3) have enough weight and strength for penetration and operation under unfavorable soil conditions, and to support strong sweeps 30 inches or more in width and spaced to allow 4 to 6 inches of overlap; and (4) have at least 18 inches clearance between sweep and beam. The blades must be adjusted to cut through the soil on a flat plane at each depth of operation. Use weight to get depth rather than increasing the pitch of the sweeps.

Generally it is best to make the first tillage operation at the greatest depth (4 to 6 inches) and each successive operation at less depth to insure seeding a firm seedbed. Rod weeders and rotary hoes can be used before seeding to control weeds and to firm the seedbed. The least tillage necessary to control weeds and prepare the seedbed is best. If the crop residue on the surface at seeding time is extra heavy, special equipment for planting such as shovel-type drills may be needed.

Combines having straw spreaders that do not leave the straw in windrows will eliminate a common cause of clogging the stubble-mulch implement. Combine sorghum in rows so that the remaining stubble will be 15 to 18 inches high.

Using the right kind of equipment is a problem in stubble mulching. A variety of machines rather than any one implement may be the most successful. Sweeps about 2 feet wide or wider normally handle surface residue most efficiently, but at times it is necessary to use the rotary hoe or skewtreader, a chisel, the one-way plow, or other secondary tillage tool.

After a heavy crop that leaves a large amount of stubble, the one-way plow can be used first to reduce the amount of residue on the surface to a more workable amount. Each trip of a one-way plow reduces by approximately 50 percent the amount of residue remaining on the surface, whereas large sweeps reduce the residue by only 10 percent.

Contour farming

In contour farming, which is widely used in Beaver County, the plowing, harrowing, planting, cultivating, or other tillage is done across the slope instead of up and down the slope. Many benefits result. Less water erosion occurs, and more rainwater soaks into the soil where it falls and is available to plants. It is easier to get a good stand, and crops tend to be more uniform in size. Farm equipment is easier and more economical to operate on the contour.

Terraced land is more efficiently farmed on the contour. Also, contour farming is effective on sloping land without terraces and can be used if east-west row direction is not needed to combat wind erosion (fig. 17).

***Figure 17.*—Contour farming with terraces holds the water where it falls.**

Minimum tillage

Minimum tillage is a fairly new conservation practice. In this practice the number of tillage and cultivating operations needed are kept to the minimum necessary to prepare the seedbed and to produce satisfactory yields. Efficient tillage saves money by eliminating a few trips over the land.

Trends indicate that, for most crops, land preparation can be reduced advantageously. If tillage is held to a minimum when a seedbed is prepared and when competitive vegetation is controlled, there will be less soil compaction, better soil aggregation, and more plant residue left on the surface to aid in controlling erosion. Minimum tillage, however, should be planned to fit the needs of a particular farm.

Stripcropping

Sandy soils that are susceptible to wind erosion can be cultivated in strips to prevent soil blowing. Most farmers in the county now plant sorghum for cover on sandy land and use the residue from this crop to control wind erosion.

In Beaver County, wheat and sorghum are grown in alternate strips. These strips should be at as near a right angle to the prevailing direction of wind during the blow season as it is practical to get them. The strips of sorghum check the wind and control erosion (fig. 18). A high stubble of sorghum should be left on the soil in winter and early in spring.

The width of the strips in wheat and those in sorghum should be the same. This width should be based on the susceptibility of the soil to erosion, which depends to a large degree on the texture of the surface soil.

In Beaver County, contour stripcropping has not been very successful in controlling water erosion.

Cover crops

Cover crops are used in Beaver County primarily to protect the soil from erosion in fields where the main crop fails. These failures are generally the result of insufficient moisture, which usually limits the choice of cover crops. Sorghum and sudangrass are most commonly used as cover crops. Because moisture is insufficient, the use of legumes is limited. When moisture is sufficient, how-

Figure 18.—**Small grains and sorghum in strips on Pratt fine sandy loam, undulating.**

ever, farmers can include a legume in their cropping system as a soil builder.

Cover crops are widely used in the county in fields or waterways being seeded to native grass. The cover crop protects the soil from erosion until the grass is established and is able to control erosion (fig. 19).

Soil-improving crops

Legumes, grasses, and other crops are used to improve the soil. Of the legumes, alfalfa and sweetclover are generally suited to soils on bottom lands. Sweetclover is the best suited. Except on the better soils or on irrigated soils, cropping systems that include legumes are not generally used in the county. If rainfall is average or above average or if the soil is irrigated, legumes grow well and can be turned under to improve the soil.

Mixtures of native grasses, or other suitable grasses, can be grown for pasture and then turned under for soil improvement. Under dryland conditions native grasses require from 2 to 4 years to establish and should be used in a long-time rotation.

Figure 19.—**Drilling native grass in a good sorghum cover. The sorghum protects the soil until the native grass furnishes cover that will control erosion.**

Small grains and other crops that produce large amounts of residue improve the soil only when the grain is harvested and the remaining residue is returned to the soil. In years when the yield of straw is high, additions of 20 to 40 pounds of nitrogen per acre are generally beneficial.

Grassed waterways

Grassed waterways are needed to carry away excess water without causing erosion. They are used with (1) terrace systems, (2) diversion terraces, (3) drainage in irrigation systems, and (4) natural drains.

Waterways can be used any place in Beaver County where there is a need for disposing of excess water without causing erosion. Waterways are not constructed to control floodwater from creeks, rivers, or very large drainage areas. Generally the waterways have shallow parabolic-shaped channels, and along each side is a berm large enough to contain the flow. In most places these waterways are protected from erosion by native grass.

Each waterway must be individually designed. The width, depth, and vegetation needed are determined primarily by the size, slope, permeability, and cover of the drainage area, and by established practices of erosion control. A local representative of the Soil Conservation Service will assist in the design, layout, construction, and seeding or sodding of your waterways.

The maintenance of waterways consists of (1) fencing, if practical; (2) mowing or spraying to control weeds; (3) lifting farm implements when crossing; (4) prohibiting use as farm roads; (5) controlling grazing; (6) fertilizing as needed; and (7) not crowding by plowing or other farming operations.

Weed control

Bindweed (*Convolvulus arvensis*) is found throughout the county, in small areas within fields. It can be eradicated by a combination of chemical and tillage measures. Soil sterilants are practical only where the areas in this weed are small and where the treatment will not increase the hazard of wind erosion. Bindweed is probably the most difficult of all weeds in the county to control in a manner that does not prevent the use of the soils for crops (fig. 20).

Emergency tillage

Although wind erosion is generally controlled by a vegetative cover, at times emergency tillage is necessary to make the soil surface rough and cloddy so that it can resist the wind.

Emergency tillage should be used only when vegetation is inadequate to protect the soil. This practice can be applied rapidly, and it helps control wind erosion for a limited time. It should not, however, be used often because it impairs the physical condition of soil and reduces the moisture content (fig. 21). The effectiveness of emergency tillage depends on the speed of equipment, depth of tillage, spacing between chisels, and size of the chisel points. For general conditions in Beaver County, the following are suggested:

1. Increase surface roughness by operating equipment at intermediate speeds of 3.0 to 4.0 miles per hour.

Figure 20.—**Bindweed keeps many acres of cropland out of production each year in the High Plains. This area is being brought back into production by treating the weed with chemicals.**

2. Plow deep enough to bring clods to the surface; the looser soils have to be worked deeper than the the tight hardlands.
3. Adjust space between chisels according to the particular area worked. Close spacing of 27 to 36 inches is more effective, but if wind erosion is only moderate, spacing of 44 to 54 inches is normally adequate. The wider spacing is especially desirable if an attempt is being made to salvage a wheat crop.
4. Use the kind of chisel points suited to the texture and compactness of the soil. A narrow chisel is less effective than a wide chisel at wide spacing, but in compacted soils, a narrow chisel of the heavy-duty type should be used.
5. Use a lister-type plow for ridging loose, sandy soils.
6. Use rows for tillage equipment that are at right angles to the prevailing wind during the windy season.

Figure 21.—**Emergency tillage is sometimes necessary to control erosion in barren fields.**

Chiseling is not recommended for sandy soils. Its effects do not last long in soils low in organic matter, because the material of these soils fuses when the soil is wet. Emergency tillage reduces the moisture content of soils. It should cover an entire area instead of strips.

Fallow

Fallow has been practiced for many years in dry-farmed areas. In Beaver County wheatland is commonly fallowed, and the increase in crop yields over those on continuously cropped land has been substantial.

Fallowed land must be kept free of weeds and also in a condition to absorb moisture. Stubble mulching is most effective because the stubble is left on the surface to protect the soil, the weeds are killed, and the soil is kept in a condition to absorb whatever moisture is available. Because of the risk of wind erosion, clean-tilled fallow is not suitable.

A year in fallow is generally alternated with a year of crops. Two different systems of fallowing are commonly used. In one, the land is tilled soon after harvest to kill weeds that would otherwise grow profusely. In the other type of fallow, the stubble field is left undisturbed from harvest until the next spring. Then, in spring and summer the weeds are killed by stubble-mulch tillage so that the surface is protected from erosion. This method requires fewer tillage operations and reduces cost of fallowing.

Deep plowing

Deep plowing can be used on some soils to help control wind erosion. It can be used only on soils that have a moderately coarse or coarse textured surface soil and a sandy clay loam subsoil. The depth of plowing ranges from 16 to 24 inches, and one-fourth to one-third of the furrow slice must be from the heavier subsoil material. After it is deep plowed, the soil should be fertilized adequately and planted to a crop that produces a large amount of residue.

Because the expense of deep plowing increases costs, only soils suited to this practice should be deep plowed. On the following kinds of soil, deep plowing may be useless or even harmful:

1. Shallow or very shallow, coarse-textured soils.
2. Soils with a dispersed or infertile subsoil.
3. Soils with slopes of more than 4 percent.
4. Soils with a high content of clay in the subsoil.
5. Soils with a very low content of clay in the subsoil.
6. Medium- or fine-textured soils.

Your local Soil Conservation Service technician can tell you whether your soils are suited to this practice.

Permanent Conservation Structures [2]

Permanent structures used in Beaver County to control erosion and to conserve water are (1) terraces, (2) erosion-control dams, (3) pipe drops, and (4) ponds for watering stock. Also, land is leveled to make better use of irrigation water and to reduce erosion on irrigated fields.

[2] This subsection was written by R. L. Bartholic, agricultural engineer, Soil Conservation Service.

Terraces

Terraces are used in Beaver County (1) to reduce water erosion; (2) to spread, conserve, and control runoff water; (3) to divert and spread water on cultivated land with slopes of 2 percent or less; and (4) to serve as guidelines for contour farming.

Terraces are used on all cultivated soils in the county except those that are subject to wind erosion and those that are nearly level and are not subject to appreciable water erosion.

All terraces in the county are run level. They may have open ends, partly closed ends, or closed ends, or a combination of these, depending on the permeability and slope of the soil. The terraces are of the channel type, impounding type, and ridge type.

Channel-type terraces are constructed by moving soil from the upper side of the ridge only (fig. 22). A channel is constructed on the upper side, since this type of terrace is designed to discharge excess runoff and control sheet and gully erosion. This surplus water is discharged

Figure 22.—**The construction of a channel-type terrace on sloping land to keep the water on the land for crop utilization.**

into a protected spill area. Channel-type terraces are built on soils that have 3 to 8 percent slopes and on the slowly and very slowly permeable soils with flatter slopes. Normally, one end is open and the other end closed, but both ends may be open. Some channel-type terraces on slopes of 1 percent or less have partly closed ends, and means to drain the channel are provided, should this become necessary.

Ridge-type terraces are constructed by moving soil from both sides of the ridge (fig. 23). These terraces are constructed on slopes of 3 percent or less. They normally have one end open or partly closed and the other end closed, but on the more permeable soils, both ends may be partly closed. All open ends must drain into protected spill areas.

Impounding-type terraces are constructed by moving the soil from a wide area below the ridge. They are built on permeable soils with slopes of 3 percent or less, and they have partly closed ends or closed ends. Infiltration is greater above this type of terrace because the surface of the ridge is not disturbed. These terraces are used for

Figure 23.—**Ridge-type terrace that is tilled on the contour. Water is held where it falls until it sinks into the soil to be used by plants.**

spreading as well as holding water. Protected outlets are not needed in most places (fig. 24).

It is important that farming operations be carried out parallel to the terraces and not across them. Terraces are designed to handle the water of the largest storm that is likely to occur in 10 years. If a larger storm occurs, extra maintenance will be needed.

Diversion terraces

Diversion terraces are used (1) to divert overhead water from cultivated land and to discharge it on a protected area, (2) to divert the discharged water from erosion-control dams to a protected area, (3) to divert the discharge water from stock-water ponds to an area away from the back toe of the dam or to another spill area, (4) to divert water from active gullies and head cuts, (5) to collect water for water-spreading systems, and (6) to break up water concentrations on large, flat, cultivated fields and in water-spreading systems. Diversion terraces

Figure 24.—**Impounding-type terraces constructed to hold the water on the land for plant utilization.**

are suited to all areas in Beaver County except those where the wind might blow soil and fill the channels.

Diversion terraces may be level, but generally they are sloping and have the lower end open and the upper end closed. They may be of the channel, ridge, or impounding type. They are constructed wide enough and smooth enough that farm machinery can be used to maintain them. If diversion terraces are not cultivated, they are maintained by mowing the vegetation to allow free movement of water. These terraces generally are not cultivated, but if they are, they should be in a small grain, alfalfa, or some other crop that does not have a long stalk. If practical, a broad strip of permanent vegetation should be established above the channel of a cultivated diversion terrace.

Each diversion terrace must be designed for the area drained, and it must have a suitable spillway. It must be built to meet the requirements imposed by slope, cover, and soil type. Terraces are designed to handle the runoff from any storm that is likely to occur in 10 years.

Diversion terraces that are wide apart will not take the place of a terrace system. The spacing between terraces is critical, and if it is too wide, channels are filled with silt and fields are damaged because of water erosion.

Diversion terraces in water-spreading systems on grassland generally function in different ways. On the steeper slopes (2 to 3 percent), weep holes or pipes are used to spread the water over a large area. As this water collects, it is picked up by the next system of weep holes or pipes and again spread over a wide area. On the flatter slopes (0 to 2 percent), the water is generally impounded over a large area and allowed to soak into the ground.

The surplus water is used in one of two ways. It is allowed to spill out on high, flat areas or on well-grassed areas and is picked up on the next diversion terrace, or it is spilled out on opposite ends of each diversion terrace and is spread the length of the field. As much water as possible is impounded in the structure before any of it is discharged. Some overhead water is also picked up and diverted into the water-spreading system.

Erosion-control dams

Erosion-control dams are of the impounding type that stores runoff water and releases it. Excess water is released through a pipe or pipes to a principal spillway that discharges at a lower level, or it flows through a diversion spillway to an area where it can be released without causing erosion.

If the pipe spillway is used, the erosion-control dam above the spillway usually controls an erosion hazard, such as an overfall, that may cut into highly productive land in cultivated fields, at the ends of waterways or large diversions, or in grass. If a diversion spillway is used, the erosion-control dam usually protects the highly productive soils below the structure from concentrated overhead water.

Occasionally, a system of diversions may be used to move overhead water from a field to an area where it is impounded by an erosion-control dam. Then the water is released at a safe rate into a safe discharge area.

Erosion-control dams should be designed so that they can impound the drainage they receive and discharge it safely. They should have a safe discharge area if a diversion spillway is used. If a pipe spillway is used, the spillway should drain the stored runoff in not more than 5 days. The storage capacity should be at least enough to contain a one-half inch of runoff.

Hood inlets may be used if airtight pipe is available. Normally, pipe spillways larger than 15 or 18 inches in diameter are of the drop-inlet type.

If a diversion terrace is used for a spillway, the terrace should be designed to carry the expected outflow. It should be constructed at the dam in a manner that will insure free flow through the spillway of the erosion-control dam. If this is not practical, additional freeboard should be maintained.

Pipe drops

Pipe-drop structures are used to lower limited flows of water to a safe discharge elevation (usually base grade) where the pipe discharge will carry the entire expected runoff.

The lower end of small waterways, terraces, and diversions can be protected by using pipe drops.

Ponds for watering stock

A primary purpose of ponds for watering stock is to distribute grazing so that the best use is made of grassland. These ponds should be close enough so that livestock is never more than half a mile from a pond or other source of water.

In some areas in Beaver County, river breaks are natural barriers and the locating of ponds is a problem. Pond construction is difficult because of the deep drains and extremely steep banks. Large cracks form in the uneven settlement along the banks, and the water enters these cracks and cuts through the fill. The steep banks must be sloped and cored, and this work makes construction difficult and expensive.

If a good vegetated spillway is not available, a pipe spillway should be installed that has enough capacity to contain the runoff from 2 days of of any storm that might occur in 25 years. A trickle pipe should be used in any pond that will have sustained flow through the spillway. Seeps or springs may be carried through trickle pipes located at an elevation just below the vegetated spillway. If pipe spillways are used, they should discharge the flood storage in not more than 5 days, but preferably in 2 or 3 days.

Reservoirs or pit ponds are used in some areas where the land is too flat to obtain the desired natural depth. These structures have square or rectangular flat bottoms and a three to one slope on three sides. On the other side, the slope is five to one so that the water is accessible to livestock. The spoil generally is spread on three sides, and the flatter slope is left open.

Reservoirs are extremely susceptible to filling by silt or other sediment, and they may be useless in a season or two if they are not protected. On larger drains, they should be constructed as a by-pass structure so that when the reservoir is full the stream does not run through the structure.

If they are to supply water to stock all year, the ponds in Beaver County should be not less than 13 feet deep.

Land leveling

Land is leveled in Beaver County to make better use of irrigation water, to conserve water, and to reduce soil erosion under irrigation. Some land has been bordered,

but most land leveling is in connection with the irrigation of row crops. Before any land is leveled, the cuts that can be made without destroying the potential of the soil should be determined.

Land leveling should be designed to fit the soil, the crops to be grown, the amount of available water, and the lay of the land. Because it is expensive to level land, a thorough investigation should be made of the need, soil potential, quality and quantity of water, markets, and other factors.

Estimated Yields on Dry-Farmed Soils

Estimated average acre yields of wheat and grain sorghum on dry-farmed soils are listed in table 2. Wheat and grain sorghum are the principal crops grown in Beaver County, and dryland farming is the main kind of agriculture practiced.

Yields on the same soil vary greatly from year to year. They are generally larger in years when the amount of rain is normal or above normal and when this rain falls at the right time. Generally the sandy soils need less moisture than hardland soils and produce higher yields in dry years, but the hardland soils produce higher yields than the sandy soils in wet years. The yields are the average that can be expected over a period of years for each soil in the county.

Yields in columns A are obtained under normal management, or the management ordinarily used by most farmers. Under normal management suitable crop varieties are used, and seeding is at the proper time and rate. Methods of planting and harvesting are efficient, and weeds, insects, and plant diseases are controlled. There is some residue management.

Yields in columns B are obtained from soils receiving normal management plus stubble mulching, good management of crop residue, fallow, contour farming, terracing, and the use of grassed waterways. These practices vary according to the needs of the soils.

The yields at the two levels of management were obtained by soil scientists, who questioned farmers during the soil survey. The farmers furnished estimates of yields on the different types of soils for 10- to 20-year periods. Because the weather varies, the yields do not apply to any specific year.

All soils under dryland farming may fail or may produce yields below average in droughty seasons. In dry years a soil that can produce about 40 bushels of wheat per acre under favorable conditions can fail as readily as one that will yield only 20 bushels. In only about 4 years in 10 are conditions in Beaver County favorable enough for production of wheat averaging more than 10.4 bushels per acre. In only 1 year in 10 do the individual soils under dryland farming produce yields that are near their potential.

The differences in yields on the different soils and under two levels of management are not so great over a period of years as one might expect. The farmer should use conservation measures and obtain the maximum production that he can under existing conditions, and he should also prevent soil losses that might lower yields considerably when seasons are favorable.

TABLE 2.—*Estimated average acre yields of wheat and grain sorghum on dry-farmed soils*

[Yields in columns A are to be expected under common management; those in columns B to be expected under improved management. Absence of figure indicates crop is not commonly grown]

Soil	Wheat		Grain sorghum	
	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*
Active dunes	----	----	----	----
Alluvial and broken land	----	----	----	----
Bippus clay loam, 1 to 3 percent slopes	10	13	13	15
Canadian fine sandy loam	10	12	8	10
Carey silt loam, 0 to 1 percent slopes	11	14	13	16
Carey silt loam, 1 to 3 percent slopes	10	12	13	15
Dalhart fine sandy loam, 0 to 1 percent slopes	10	14	18	21
Dalhart fine sandy loam, 1 to 3 percent slopes	10	12	17	20
Las Animas soils	----	----	----	----
Likes loamy fine sand	----	----	----	----
Lincoln soils	----	----	----	----
Mansic clay loam, 1 to 3 percent slopes	9	12	11	12
Mansic clay loam, 3 to 5 percent slopes, eroded	7	10	8	10
Mansic soils, severely eroded	----	----	----	----
Mansic-Otero complex, 1 to 3 percent slopes	8	10	14	19
Mansic-Woodward complex, 1 to 3 percent slopes	9	12	10	12
Mansic-Woodward complex, 3 to 5 percent slopes, eroded	7	10	11	13
Mansker clay loam, 1 to 3 percent slopes	8	10	10	12
Mansker clay loam, 3 to 5 percent slopes	5	7	7	9
Mansker-Potter complex	----	----	----	----
Otero soils, 3 to 5 percent slopes, eroded	----	----	4	6
Otero-Mansker complex	----	----	----	----
Otero-Pratt fine sandy loams, 3 to 12 percent slopes	----	----	----	----
Pratt fine sandy loam, undulating	9	11	16	20
Pratt loamy fine sand	7	9	15	17
Pratt-Tivoli loamy fine sands	----	----	----	----
Pullman clay loam	11	14	10	16
Randall clay	----	----	----	----
Richfield clay loam, 0 to 1 percent slopes	12	14	13	16
Richfield clay loam, 1 to 3 percent slopes	10	12	10	12
Richfield loam, thick surface	13	16	16	19
Richfield-Mansic clay loams, 3 to 5 percent slopes	9	11	9	11
Spur soils	12	14	14	18
Tivoli fine sand	----	----	----	----
Ulysses silt loam, 0 to 1 percent slopes	11	14	14	18
Ulysses silt loam, 1 to 3 percent slopes	10	12	10	13
Ulysses silt loam, 3 to 5 percent slopes	8	10	9	12
Ulysses-Richfield complex	10	13	13	14
Vernon loams	----	----	----	----
Woodward-Mansic complex	----	----	----	----

Irrigation[3]

Although a much larger acreage is dry-farmed in Beaver County than is irrigated, many farmers irrigate some of their soils. Most of the irrigated acreage in the county is used for feed crops because the market for many crops is limited and labor is scarce.

Estimated Yields on Irrigated Soils

The main crops grown under irrigation in Beaver County are grain sorghum, wheat, forage sorghum, and

[3] This section was written by GRANT WOODWARD, civil engineer, Soil Conservation Service.

TABLE 3.—*Estimated average acre yields of principal crops on irrigated soils under two levels of management*

[Yields in columns A are to be expected under common management; yields in columns B are to be expected under improved management]

Soil	Wheat		Grain sorghum		Forage sorghum (ensilage)		Alfalfa	
	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Canadian fine sandy loam	22	42	55	100	12	22	3.5	6.0
Carey silt loam, 0 to 1 percent slopes	25	48	55	100	14	24	4.0	7.0
Dalhart fine sandy loam, 0 to 1 percent slopes	21	40	47	83	10	19	3.0	5.0
Pullman clay loam	25	45	55	100	12	22	3.5	6.0
Richfield clay loam, 0 to 1 percent slopes	25	45	55	100	12	22	3.5	6.0
Richfield loam, thick surface	28	50	60	108	14	24	4.0	7.0
Spur soils	25	45	55	100	12	22	3.5	6.0
Ulysses silt loam, 0 to 1 percent slopes	25	45	55	100	14	24	4.0	7.0

alfalfa. Estimated average acre yields for these crops are given in table 3.

Only the soils in the county suitable for irrigation are listed in table 3. The estimated yields of these soils are based on information obtained from local farmers and other agricultural workers.

In columns A are yields to be expected under common management. This management includes the use of suitable crop varieties; proper seeding and harvesting; and the control of weeds, insects, and plant diseases. Yields in columns B can be expected under improved management. Improved management provides land leveling, improved application of water, the proper use of irrigation water, the rotation of crops, and other practices that conserve moisture and protect the soils from erosion.

Supply of Water

Most of the irrigation water in Beaver County is pumped from wells (fig. 25) because dependable sources of water from streams are scarce. The Beaver River across the northern part of the county and Six Mile, Clear, and Duck Pond Creeks through the central part, flow during much of the year, but these streams are not dependable sources of water. Irrigation has not developed along them to a large extent. The Cimarron River along the northern border of the county and Kiowa Creek in the southeastern corner have the most dependable supplies of water. The quality of water, however, in the Cimarron River is questionable, and irrigable land along the river is scarce. There is more good land along Kiowa Creek than can be irrigated by the available water.

Remains of old canals along the Cimarron River show that land in that area was irrigated before the county was opened for settlement. The Ditch Valley Irrigation District now diverts the water from the Cimarron River at a point just below Horse Creek in Beaver County and uses

Figure 25.—**Irrigation water pumped from a well.**

this water in adjoining Harper County. Earlier, irrigation water was pumped from a sump at the edge of Clear Creek east of the town of Beaver and also from shallow underground supplies along Kiowa Creek. One of the deep wells (more than 100 feet deep) used earlier was about 2 miles east of Gate.

In November 1939, several shallow test wells were made and a number of shallow, low-yielding wells were drilled in the alluvial deposits of the streams. But irrigation was not important until the early 1950's when wells into the deeper aquifers in the High Plains were drilled. These wells were 200 to 450 feet deep. Irrigation increased rapidly for about 8 years, and a total of 10,575 acres was irrigated before the increase slowed. Only about 1,000 acres of this was irrigated from surface water; the rest was irrigated from underground water.

The water in the High Plains is generally of good quality, although it is moderately hard. That in the alluvial deposits along the streams varies in quality; it is good in some place and is highly mineralized in others.

Nearly all the underground water is supplied by the lakebed formation near Gate, by the deep formation of the High Plains, or by the alluvial deposits along the streams of the county. The water-bearing material consists of coarse sand that varies greatly in thickness of layers and in size of particles. This sand is separated by layers of clay in many places. It is so lacking in uniformity that expected yields of water cannot be estimated accurately. Test wells have to be drilled to determine the possible yield in a specified location. Sands from the test well should be analyzed to assure that the well is properly packed with gravel to permit it to furnish a maximum amount of irrigation water. Drilled wells and cased wells should always be made with a test pump to minimize sand wear on the impellers and bearings of the irrigation pump that is installed in the well.

Requirements for Irrigation

In deciding whether or not irrigation will pay, a farmer should consider (1) his soils, (2) the available water, and (3) the crops that can be grown.

Soils.—A soil suitable for profitable irrigation must (1) be productive, (2) absorb and store large quantities of water for the use of plants, (3) have only mild slopes, (4) be permeable enough to control the accumulation of harmful salts, (5) have adequate drainage, and (6) have a root zone thick enough for plants.

The soils in Beaver County that meet the foregoing requirements and are suitable for irrigation are listed in table 3.

Water.—An adequate supply of water of good quality must be available. In Beaver County the water supply is generally limited, and in some places where it is adequate, the water is of poor quality. The farmer should check the water supply for both quantity and quality before deciding to irrigate.

Crops.—Irrigation will not be profitable unless crops can be grown that can be sold or that will improve the condition of the soil. Grain sorghum and wheat have been the chief cash crops produced under irrigation in the county. Alfalfa is raised successfully and improves the physical condition of the soil to the extent that yields of the crops that follow are increased. Potatoes, onions, lettuce, spinach, and other truck crops have been successfully grown, but a satisfactory market for these crops is not always assured. Both grain and forage sorghum are highly productive under irrigation if they are adequately fertilized.

Irrigation Methods

The three general ways of irrigating soils in Beaver County are (1) by flooding, (2) by furrows or corrugations, and (3) by sprinklers. If it can be done without excessive cost, land is generally leveled before it is prepared for irrigation by flooding or by furrows or corrugations. Cultivating land that has been field leveled has many advantages. The borders can be changed yearly to reduce infestation by weeds. Farming operations are easier because the leveled land can be farmed in larger plots without interference of permanent borders and without the necessity of maintaining a level area between the border ridges.

Flooding.—Irrigation by flooding can be by the border method or by flooding from contour ditches. In the border method, either parallel straight borders or borders on the natural contour can be used.

In the method of flooding that uses parallel borders, the borders control the direction of flow on nearly level soils that have been divided by these borders into plots of suitable size. Border irrigation can be used on most soils except those that are too permeable. Runs on very permeable soils would have to be too short for practical farming. Parallel-border irrigation requires relatively large streams of water, but it permits efficient, rapid, and relatively easy application of water and requires little labor.

In the contour-border method, the borders are constructed along the natural contours. This method of irrigation requires very little land leveling, and it can be used on shallower soils than can the parallel-border method. Only pasture crops can be grown, however, because other crops are difficult to harvest. Also, it is difficult to determine the area within contour borders and how much water is needed for irrigation.

Contour-ditch flooding is frequently called wild flooding. By this method irrigation water is carried to the field in a nearly level ditch on the contour. The water is released, and a sheet of it flows over the field and is controlled only by gravity. This method is used to irrigate small grains, alfalfa, and clover. It requires little land leveling and only a small head of water. It is best suited to shallow soils that have considerable slope and soils on irregular hillsides. If a small grain is grown, temporary ditches are constructed and filled in before harvest.

This method is inefficient and should not be used where other methods are practical. Because the application of water is uneven, crop stands are uneven, different parts of a crop mature at different times, and production is low.

Furrows or corrugations.—By this method the flow of water is controlled in furrows of various size and spacing. Corrugations are very small rows and furrows used for irrigating small grains and other close-growing crops. Row crops are irrigated more easily in larger furrows (fig. 26). If the maximum slope of a field is more than 0.5 percent, borders generally should be installed in the furrow, or corrugation, system.

Furrows, or corrugations, are suited to nearly all kinds of soils. On the more permeable soils, however, the rows must be very short unless the water is carried to the rows in a gated surface pipe and the rows are irrigated in segments.

Furrow irrigation is an efficient and suitable method of irrigating row crops. Small quantities of water can be efficiently used. Rows must be maintained throughout the year, however, and drilled crops are difficult to harvest.

Sprinklers.—In the sprinkler method, water is conveyed to the field in a pipeline and is distributed on the field under pressure through nozzles or perforated pipes (fig. 27). Although no water is lost through seepage in ditches, more water is lost through evaporation than in other methods. Sprinklers are not efficient when the wind velocity is more than 15 miles per hour. If runoff from rainfall is likely to cause erosion, adequate practices of erosion control must be used with sprinklers.

Figure 26.—**Milo irrigated by the furrow method.**

Figure 27.—Sprinklers irrigating alfalfa.

The sprinkler method requires little or no land leveling or smoothing and requires no facilities to drain irrigation water. Very small amounts of water can be applied efficiently. Portable systems do not obstruct tillage, for they can be removed from the fields. Most of the equipment in a sprinkler system can be moved from the field, and it has a resale value.

However, the initial investment and the operating costs are high. Portable systems are difficult to move on fine-textured soils that are under cultivation. Particularly on soils that have a fine-textured surface soil, sprinkler irrigation is not suitable on slowly permeable or very slowly permeable soils. The use of sprinklers may increase the growth of fungus, and it impairs the fruiting of some crops.

Range Management [4]

Grassland in Beaver County amounts to about 538,800 acres and makes up about 47 percent of the total agricultural land. Most of this range is along the Beaver and Cimarron Rivers and their tributaries. About 3,000 acres of the grassland is used primarily as native hay meadow. In most places the native grassland is shallow, droughty, steep, or susceptible to severe erosion and, therefore, is not suited to cultivation.

Livestock is the second largest agricultural industry in the county and provides an average total income of about 4 million dollars yearly. The 66 true ranch units in the county cover about 241,800 acres and contain about half of the rangeland. Cattle, however, are also on 88 percent of the farms, and in 1959 there were 85 dairies in the county.

The number of cattle in the county is generally between 40,000 and 52,000. There were about 40,000 cattle in the county in 1936, only a few more in 1947, and a considerably larger number during the war years (1941 to 1945). The number increased to the all-time high of 52,390 head in 1953, but by 1959, the number had decreased to 49,843. About a fourth of the cattle are stockers or feeders, and 3,000 cows were milked in grade A dairies in 1959. The rest of the cattle in the county were beef cattle or calves.

[4] This section was written by E. C. Snook, range specialist, Soil Conservation Service.

The sandy soils in the county were originally covered with mid and tall grasses and scattered sagebrush. Because of overuse, selective grazing, and other harmful practices, the composition of the grasses on the range has changed and the grassland is producing only about half the forage it is capable of producing.

Some of the deterioration of the grassland is the result of droughts and the large number of cattle grazed during World War II, but other factors are probably more significant in the long run. Operators tend to carry more cattle than the native range will support and do not keep enough reserve feed. The amount of reserve needed depends on the amount of moisture available to the range plants. If moisture is not adequate, pasture plants grow slowly and supplemental feed is needed. If this feed is not available, the native ranges are often overgrazed. The overgrazing causes a further decrease in available moisture, for the soils do not have enough mulch on the surface and are often too hard and crusted for water to penetrate rapidly when it rains. If because of drought the range is depleted and the cultivated crop fails, the rancher may find it difficult to reduce the number of cattle. During such periods feed costs will normally be high unless a large reserve is kept on hand.

Range Management Principles

Rangeland generally can be conserved by adjusting the number of livestock and the periods of grazing so that the best native grasses have a chance to grow. The essential stages in the growth of grasses are leaf development, root growth, flower stalk formation, forage regrowth, and food storage in the roots. Grazing should be light enough to allow for these phases of natural growth if high yields of forage and of beef are to be obtained.

Results of research and the experiences of stockmen have shown that the range will improve only when no more than about half of the yearly volume of grass produced is removed. The grass left on the ground does these things:

1. Serves as a mulch that causes rapid intake and storage of water.
2. Allows roots to reach deep moisture because root growth is greater when there is more top growth.
3. Gives the grass a better start for growth in spring.
4. Protects the soil from wind and water erosion.
5. Holds rain and snow where they fall so that more water soaks into the soil.
6. Allows the better grasses to crowd out weeds.
7. Enables plants to recover more rapidly after droughts.
8. Provides a greater reserve of forage for the dry spells that might force the sale of livestock at a loss if reserve forage were not available.

Livestock graze selectively; they constantly seek out the more palatable and nutritious plants. The less desirable, or second-choice, plants increase on pastures that are overgrazed. If overgrazing is continued, even the second-choice plants can be thinned out or eliminated and unpalatable weeds or invaders take their place.

Sound range management requires that grazing use be adjusted from season to season according to the growth of grazing plants. Reserve pastures or other feed should

be provided for use during droughts or in other periods when forage production is low. This permits a moderate use of forage at all times. In addition to maintaining forage and feed reserves, the rancher can increase flexibility by keeping part of his livestock as stocker steers or other stock that is easy to sell. Such flexibility allows him to balance his livestock with forage production without sacrificing breeding animals.

To enable him to use the best practices in improving his grassland, the rancher should know the more important range plants and their combinations. He should understand signs that indicate whether his range is getting better or worse. Important changes in the kinds of grasses often take place gradually and can be overlooked or misunderstood by someone who is not acquainted with the vegetation and the soils. Sometimes plant growth stimulated by favorable rainfall leads to a conclusion that the range is improving when actually the long-time trend is toward poorer grasses and lowered production. On the other hand, a range in good or excellent condition that is closely grazed for one season may appear degraded, but it is capable of rapid recovery through proper stocking and favorable precipitation.

Factors of Range Management

To use rangeland efficiently and bring about improvement, a rancher should limit the number of livestock and the season of use to the kinds and amounts of available forage. He should also obtain proper distribution of grazing, control undesirable weeds, and plant suitable grasses.

Proper grazing use.—Proper grazing is the most important of all range practices. Because the leaves of grass convert the energy of the sun into starch, sugar, fat, and other food products, grazing should be controlled so that enough leaf surface is left for these vital processes to continue. Plants that are grazed heavily are likely to be stunted because not enough leaf surface remains for the growth processes to operate efficiently. The least palatable grasses and those that have low or a mat-type growth are most likely to survive.

In setting up a conservation program for rangeland, it is most important to control the number of livestock on the range so that about half of the yearly growth of plants is left ungrazed. The rancher should become familiar with his range sites. He should understand the signs of improvement or continued decline and adjust the number of livestock to the condition of his range as indicated by these signs. If advice is needed on the stocking rate or on other factors in range management, the Beaver County Soil Conservation District and other agricultural agencies in the area have specialists who will gladly advise him.

Distribution of grazing.—Especially on pastures that have more than one range site, the distribution of grazing may be a problem. Fencing may be needed on these pastures, but the cost of fencing and the expected return in increased forage must be considered.

The rancher should use the most economical kind of water facilities and should locate the watering places so that they will encourage an even distribution of grazing. Watering facilities include ponds, wells, springs, and pipelines. The spacing of watering places to encourage distribution of grazing will vary according to topography. On relatively smooth topography, watering places can be located 1½ miles to 3 miles apart, but in rough areas they need to be about ½ to ⅔ mile apart.

Salting is also used to encourage an even distribution of grazing. Salt can be moved easily from place to place or withheld from selected permanent salt locations to attract the livestock to lightly grazed areas. It can also be placed at points that will attract the livestock away from watering places and thus distribute the grazing more evenly.

Deferred grazing.—Leaving the land idle in summer helps seriously depleted range to recover more rapidly. If the rancher, however, wishes to leave a pasture idle during summer, he must consider whether or not this will cause his other pastures to be overgrazed. The rancher is fortunate if he has one or more pastures in reserve and still can keep his other pastures only moderately stocked. Temporary pasture or cropland can be used for grazing to permit other pastures to be left idle.

Control of brush and weeds.—If brush and weeds have increased or invaded to the extent that forage production is materially decreased, proper control measures should be used, except on steep sand dunes where such cover is needed for erosion control.

Weeds normally can be controlled through good grazing management. Chemical control or mowing, however, may be needed for highly competitive perennial weeds such as western ragweed.

Seeding of native grasses.—The seeding of native grasses in areas not suited to cultivation and in formerly cultivated fields is an important part of the conservation program in Beaver County. About 150,000 acres have been seeded to grass, and about 65,000 acres of cropland should be converted to permanent grassland.

In addition to the cropland that should be converted to pasture, there are formerly cultivated, old fields that provide little forage. Natural revegetation in these old fields is slow. In some places 40 years or more of good management have been required to establish a good stand of desirable grasses. This process is greatly speeded if these fields are seeded to grass.

The rancher should select the mixture of native grasses best suited to the range site or sites in the field. For example, blue grama should be an important part of the mixture seeded on the Hardland range site, and side-oats grama should make up a large part of the mixture seeded on the Shallow range site and on the several range sites in sandy soils.

The Hardland range site should be seeded to a mixture that consists mostly of blue grama, side-oats grama, and buffalograss. Western wheatgrass and vine-mesquite do well in areas that receive more than the average amount of water from runoff. The range sites consisting of sandy soils should be seeded to a mixture made up of little bluestem, side-oats grama, sand bluestem, switchgrass, blue grama, and similar grasses. The Deep Sand range site should be seeded to a mixture of the taller grasses such as sand bluestem, switchgrass, Indiangrass, little bluestem, and sand lovegrass.

Revegetated fields should be fenced until the seeded areas and the adjacent native range have a similar plant cover. Cattle tend to concentrate grazing on the reseeded areas at least for several years after the stand is established, and better control can be maintained during that period if the reseeded areas are fenced.

Range Sites

A range site consists of areas of grassland that differ from other areas in the ability to produce a significantly different kind and amount of climax, or original, vegetation. A significant difference is one large enough to require different grazing and other management to maintain or to improve the condition of the range. Climax vegetation is the combination of plants that originally grew on a site. Generally, it is the most productive combination of forage plants that can be grown.

Soils that are similar in their ability to produce native grasses are grouped together into range sites, and the rancher should know the range sites and soils on his range. Then he can best manage his rangeland for its highest potential production.

Range condition.—The condition of a range site can be classed according to the percentage of the present vegetation that is climax vegetation. A range is in *excellent* condition if 76 to 100 percent of the present vegetation is climax vegetation; it is in *good* condition if 51 to 75 percent of the present vegetation is climax; in *fair* condition if 26 to 50 percent is climax; and in *poor* condition if 0 to 25 percent is climax.

A rancher wants his range in excellent or good condition because such range produces high yields of forage and has a great deal of cover that helps conserve soil and water. The rancher should first determine the condition of his range and then take steps to improve this condition. To assist the rancher in determining the condition of his range, the soils of Beaver County have been grouped into range sites; and grasses suitable for the soils are given.

SUBIRRIGATED RANGE SITE

Las Animas soils are the only soils in this range site. These soils are in lowland areas along rivers and large creeks. Because of their sandy substratum, these soils have a high water table within reach of deep-rooted range plants.

When this range site is in excellent condition, the dominant grasses are switchgrass and Indiangrass and the understory is alkali sacaton and Indian saltgrass (fig. 28).

Figure 28.—**An excellent Subirrigated range site with the taller grasses dominant.**

Figure 29.—**A Sandy Bottom Land range site on which sand bluestem and little bluestem are the dominant grasses.**

Although its total area is small, this is the most productive range site in the county. Because moisture is available most of the grazing season, forage yields are less variable than on other soils.

LOAMY BOTTOM LAND RANGE SITE

Spur soils are the only soils in this range site. These are loamy soils, mostly in cultivation, along the main creeks and rivers in the county. They are occasionally flooded or receive runoff water from adjacent higher soils.

The grasses on this site are switchgrass, western wheatgrass, vine-mesquite, and blue grama. Overgrazing results in a short grass cover.

SANDY BOTTOM LAND RANGE SITE

The soils in this range site are on bottom lands along the main streams in the county. They are likely to be flooded frequently or to receive water from soils on uplands (fig. 29). The soils in this site are:

Canadian fine sandy loam.
Lincoln soils.

Some parts of this range site have a water table within reach of the deep-rooted grasses. This site will normally support switchgrass, sand bluestem, little bluestem, and other tall grasses. Short grasses and sand sagebrush increase if the range is overgrazed.

DEEP SAND RANGE SITE

In this range site are deep soils on gently rolling uplands or on low dunes (fig. 30). The largest areas of these soils are on the northern side of the Beaver River, in a belt 1 to 7 miles wide. Smaller areas are in the northeastern and northwestern parts of the county. The soils in this site are:

Likes loamy fine sand.
Pratt loamy fine sand.
Pratt-Tivoli loamy fine sands.

Although these soils are low in available water-holding capacity, they are suited to tall grasses and woody plants because they give up water readily and there is very little runoff.

Figure 30.—Pratt loamy fine sand in the Deep Sand range site.

In a long period that includes wet and dry years, forage yields fluctuate on this site more than on any other in the county. Fluctuating yields are a problem because it is difficult to stock the range with a base herd.

Under the best conditions the principal grasses are sand bluestem, little bluestem, and switchgrass. Under abusive management sand sagebrush, yucca, sand dropseed, and annuals may dominate and reduce the grass to almost nothing. Signs of heavy use are trails between clumps of sagebrush and the clumps broken up by the cattle in search of grass. Heavy grazing results in gullying and active erosion along major drainageways. Controlling brush with herbicides, deferred grazing, and other good management will result in a great increase in forage.

SANDY PLAINS RANGE SITE

In this range site are deep, moderately sandy soils on hummocky to gently rolling uplands (fig. 31). These soils are mainly in an area north of the Beaver River. They are:

Figure 31.—Sandy Plains range site in fair condition. Blue grama and side-oats grama are the dominant grasses.

Dalhart fine sandy loam, 0 to 1 percent slopes.
Dalhart fine sandy loam, 1 to 3 percent slopes.
Otero-Pratt fine sandy loams, 3 to 12 percent slopes.
Pratt fine sandy loam, undulating.

Mid and tall grasses grow well on these soils. Large amounts of sand bluestem and little bluestem indicate that the range is in good to excellent condition. Blue grama and sand dropseed are the grasses that increase as the taller grasses are reduced by heavy grazing. Sand sagebrush is an increaser if this site is heavily grazed for long periods.

LIMY SANDY PLAINS RANGE SITE

In this range site are moderately sandy and loamy, highly calcareous soils on gently undulating to undulating slopes that are broken in a few places by steep breaks and drainageways (fig. 32). These soils are south of the Beaver River. They are:

Mansic-Otero complex, 1 to 3 percent slopes.
Otero soils, 3 to 5 percent slopes, eroded.
Otero-Mansker complex.

Figure 32.—Limy Sandy Plains range site in fair condition. The dominant grass is side-oats grama, and there is some scattered sand sagebrush.

Mid and tall grasses grow on these soils. A range in good to excellent condition has a large amount of little bluestem and side-oats grama. A decrease of little bluestem and an increase in side-oats grama and hairy grama indicate heavy grazing, or that the range is decreasing in its productiveness. Scattered sand sagebrush is common on this site.

DUNE RANGE SITE

Tivoli fine sand is the only soil in this site. This soil is on dunes that are difficult to keep stabilized under the best of management. It is mainly along the northern bank of the Beaver River.

Productivity is low on this soil, and grazing should be kept to a minimum so that enough cover is maintained for protection. Areas in poor or fair condition may require complete protection from grazing until the range cover is restored. Increased stands of little bluestem and sand bluestem indicate that the condition of the dunes is improving.

Figure 33.—**Loamy Prairie range site. Blue grama and buffalograss are dominant on slopes, and western wheatgrass and switchgrass are dominant in drains and in other areas receiving more than average moisture.**

LOAMY PRAIRIE RANGE SITE

This site consists of deep, loamy soils on gently sloping to moderately sloping prairie uplands (fig. 33). These soils are in all parts of the county except the northwestern part. They are:

Carey silt loam, 0 to 1 percent slopes.
Carey silt loam, 1 to 3 percent slopes.
Ulysses silt loam, 0 to 1 percent slopes.
Ulysses silt loam, 1 to 3 percent slopes.
Ulysses silt loam, 3 to 5 percent slopes.

Range improvement is indicated by an increase of little bluestem, side-oats grama, and western wheatgrass. If the range is in good to excellent condition, the blue grama should be healthy and bunched instead of forming a thick, sodlike turf.

HARDLAND RANGE SITE

In this range site are gently sloping clays, clay loams, and loams on uplands (fig. 34). These soils are scattered through the county. They are:

Figure 34.—**Hardland range site that has had deferred grazing and good management. The blue grama is vigorous and makes up a large part of the grasses.**

Bippus clay loam, 1 to 3 percent slopes.
Mansic clay loam, 1 to 3 percent slopes.
Mansic clay loam, 3 to 5 percent slopes, eroded.
Mansic-Woodward complex, 1 to 3 percent slopes.
Mansic-Woodward complex, 3 to 5 percent slopes, eroded.
Mansker clay loam, 1 to 3 percent slopes.
Mansker clay loam, 3 to 5 percent slopes.
Pullman clay loam.
Randall clay.
Richfield clay loam, 0 to 1 percent slopes.
Richfield clay loam, 1 to 3 percent slopes.
Richfield loam, thick surface.
Richfield-Mansic clay loams, 3 to 5 percent slopes.
Ulysses-Richfield complex.

These soils are droughty because they take in water slowly and do not readily give up this moisture to grasses. In most places the site supports the short grasses of the High Plains, mainly blue grama and buffalograss.

The taller grasses such as vine-mesquite, western wheatgrass, and side-oats grama grow mainly in drainageways and in other areas that receive more than average moisture. If the Hardland range site is subjected to years of overgrazing and to droughts, the taller, more productive blue grama tends to decrease and the shorter buffalograss tends to increase. Improvement on this site is indicated by a large amount of bunchy, vigorous blue grama and other tall grasses in areas that receive more than average moisture.

SHALLOW RANGE SITE

In this site are shallow, gently sloping to steep soils. These soils generally have a shallow, loamy surface layer, and caliche or red beds are exposed or close to the surface. These soils are mainly in the southwestern, south-central, and eastern parts of the county. The soils in this site are:

Mansic soils, severely eroded.
Vernon loams.

The layers of caliche or the red beds prevent the growth of dense plant roots in the top layers, but in some areas roots penetrate deeply through cracks and seams in the rock and take in moisture readily. The stand that grows is open and has many bare spaces, but the dominant grasses are taller than those normally found on the Hardland range site.

Range in excellent condition has much side-oats grama, hairy grama, and little bluestem. An increase of short grasses and hairy tridens is a sign of grazing abuse.

MIXED HARDLAND AND SHALLOW RANGE SITE

This range site consists of some of the soils that are in the Hardland range site and some that are in the Shallow range site (fig. 35). These soils are generally along the tributaries of the large creeks and rivers in the county. The soils are so intermingled that it is not practical to separate them into their respective range sites. The soils in the Mixed Hardland and Shallow range site are:

Alluvial and broken land.
Mansker-Potter complex.
Woodward-Mansic complex.

The vegetation in this site is like that described for the Shallow range site and the Hardland range site. Where these two sites occur together, there is a difficult problem of grazing distribution. For example, if the blue grama were the main grass on the Hardland part of this range site, it could be overgrazed and the dominant side-oats grama on the Shallow part could be undergrazed.

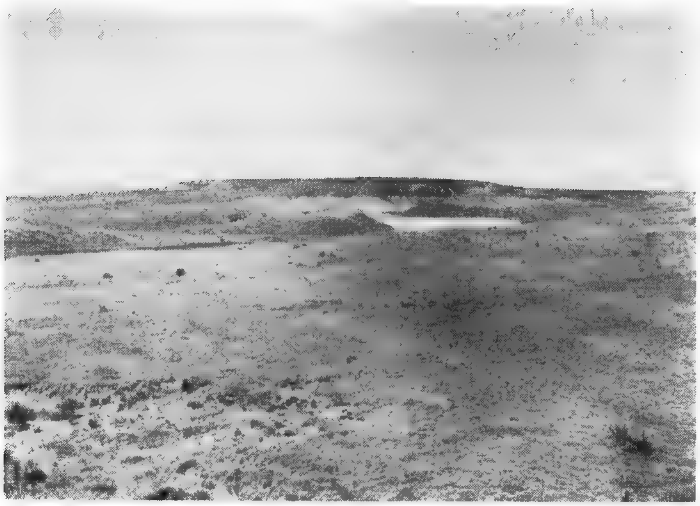

Figure 35.—**Mixed Hardland and Shallow range site. The soils are the Mansker-Potter complex. Native grass on these soils needs good grazing management to maintain the grass cover wanted.**

Range Forage Yields

The production of forage on range in Beaver County is highly variable. Because of this variability, the rancher should keep good feed reserves in the form of deferred and lightly grazed pasture or in the form of hay and silage.

Estimated yields on major range sites in Beaver County that are in good to excellent condition are listed in table 4 for favorable and unfavorable years, or years when the weather is favorable and when it is unfavorable for the growth of forage plants. These estimates are not for years when the weather is extremely good or extremely bad.

TABLE 4.—*Annual yields of forage*[1] *on major range sites when weather is favorable and unfavorable*

Range site	Estimated yield in—	
	Favorable years	Unfavorable years
	Lb.	*Lb.*
Hardland	2, 200	950
Shallow	1, 900	1, 000
Sandy Plains	2, 500	1, 100
Deep Sand	3, 000	1, 400
Subirrigated	8, 000	5, 000

[1] Air-dry weight.

Woodland and Windbreaks[5]

Only a small acreage in Beaver County is woodland. This woodland is along the Beaver and Cimarron Rivers, and more abundantly along the numerous tributaries of these streams. Elm, cottonwood, willow, ash, and hackberry are the most common trees, and walnut and western soapberry grow in some places. The trees in the county produce only a small amount of wood products, but they do have some value in protecting livestock and in providing habitats for wildlife.

Some trees have been planted in windbreaks to protect dry-farmed fields, but these windbreaks have not been practical. Because of the wide spacing necessary between rows if the trees are to survive, much cropland is taken up wherever windbreaks are installed. Also, the trees must be cultivated frequently, and even with this care, they do not grow tall enough to give much protection.

Tree planting to protect farmsteads and livestock is feasible. Although spacing between trees is wide, these windbreaks do not occupy a large acreage and the trees do not have to be very tall to accomplish their purpose. Excellent year-round windbreaks are provided by Austrian and ponderosa pines, Rocky Mountain and one-seed junipers, eastern redcedar, some varieties of arborvitae, and other conifers. Chinese elm (*Ulmus parvifolia*) and Siberian elm (*U. pumila*) are often used alone or in combination with the evergreens to provide earlier protection and shade. The Chinese elm is better suited to soils on the High Plains than the Siberian elm. Willow and tamarisk provide a very effective shrub row if they are pruned back every 1 or 2 years. Black locust, Osage-orange, and catalpa can be grown in some areas of Canadian fine sandy loam.

The soils in the county have been placed in three classes according to their suitability for farmstead windbreaks. These classes are suitable, suitable with limitations, and unsuitable. Soils are *suitable* for windbreaks if they are in suitable locations and have good moisture intake and retention qualities. They are *suitable with limitations* if they require supplemental water and exceptionally wide spacing between trees. Soils that lack good intake or retention qualities or that are shallow are *unsuitable* for windbreaks.

Soils are listed according to their suitability for windbreaks as follows:

SUITABLE
- Canadian fine sandy loam.
- Carey silt loam, 0 to 1 percent slopes.
- Dalhart fine sandy loam, 0 to 1 percent slopes.
- Dalhart fine sandy loam, 1 to 3 percent slopes.
- Las Animas soils.
- Likes loamy fine sand.
- Lincoln soils.
- Mansic-Otero complex, 1 to 3 percent slopes.
- Mansic-Woodward complex, 1 to 3 percent slopes.
- Otero soils, 3 to 5 percent slopes, eroded.
- Pratt fine sandy loam, undulating.
- Pratt loamy fine sand.
- Spur soils.
- Ulysses silt loam, 0 to 1 percent slopes.

SUITABLE WITH LIMITATIONS
- Bippus clay loam, 1 to 3 percent slopes.
- Carey silt loam, 1 to 3 percent slopes.
- Mansic clay loam, 1 to 3 percent slopes.
- Mansic clay loam, 3 to 5 percent slopes, eroded.
- Mansic-Woodward complex, 3 to 5 percent slopes, eroded.
- Mansker clay loam, 1 to 3 percent slopes.
- Mansker clay loam, 3 to 5 percent slopes.
- Otero-Pratt fine sandy loams, 3 to 12 percent slopes.
- Pratt-Tivoli loamy fine sands.
- Pullman clay loam.
- Richfield clay loam, 0 to 1 percent slopes.
- Richfield clay loam, 1 to 3 percent slopes.
- Richfield loam, thick surface.

[5] This section was written by HERB R. WELLS, soil conservationist, Soil Conservation Service.

Richfield-Mansic clay loams, 3 to 5 percent slopes.
Ulysses-Richfield complex.
Ulysses silt loam, 1 to 3 percent slopes.
Ulysses silt loam, 3 to 5 percent slopes.

UNSUITABLE
Active dunes.
Alluvial and broken land.
Mansic soils, severely eroded.
Mansker-Potter complex.
Otero-Mansker complex.
Randall clay.
Tivoli fine sand.
Vernon loams.
Woodward-Mansic complex.

Wildlife

Beaver County has large numbers of various kinds of wildlife in the rolling red plains. Wildlife is less numerous in the High Plains but is of about the same kinds as are in the rolling red plains.

The best places for wildlife are the many shallow valleys, the somewhat more abrupt valleys along the creeks, and the areas along the Beaver and Cimarron Rivers. Many of the creeks are spring fed, and although shallow, maintain a fairly dependable flow throughout the year.

Except on some hardlands in short grass, bobwhite quail are common throughout the county. They are along the Beaver and Cimarron Rivers and are more plentiful in areas of Tivoli soils where the cover is tall grass and sand sage. Up the tributaries of the two rivers, the number of quail decreases. They are in good numbers in a few places on the Otero and Pratt soils in the eastern part of the county. The number of quail can be increased best by protecting the native vegetation from fire and livestock.

Doves nest in suitable places throughout the county and are especially plentiful in migration periods. Prairie chickens are not so plentiful as doves, but they are fairly abundant in the northeastern part of the county between the Cimarron and Beaver Rivers. Among the factors that favor an increase in the number of prairie chickens and doves is the trend toward larger ranches, the improved use of range, increased water facilities, and organized fire suppression.

Though most early attempts to restore the wild turkey failed, recent stocking in areas of reliable water supply and suitable timber is encouraging. A number of sizable flocks are now in the county. Probably because a suitable range is lacking, limited stocking of scaled quail has failed to build up a high population, even though these birds were once numerous in some localities.

Ringnecked pheasants are widely dispersed throughout the county as a result of many introductions and of possible migration from Kansas. Though they vary in number from year to year, ringnecked pheasants are numerous in wet alluvial flats and along the drainage systems in the agricultural upland areas dominated by the Dalhart soils. Open season is set each year according to the number of pheasants in the county.

The major streams attract flocks of wildlife during their migration. On the flood plains of the Beaver and Cimarron Rivers, sinkholes 1 or 2 acres in size are excellent resting places for migrating birds. Considerable food is frequently provided by marsh vegetation and by seed washed in from plants on uplands. Particularly in areas where grain sorghum and wheat are grown, the game on pluvial lakes provide good shooting at times.

Big game is not hunted in Beaver County. Only a herd or two of the formerly abundant antelope are in the county, and only an occasional whitetail deer is seen along the rivers. A large number of cottontail rabbits live on the bottom land, and there are a few squirrels in the trees along drainageways.

Though little fur is taken, all of the furbearers and predators common in the southern part of the plains are present in the county. More pelts are taken from coyotes than from all other animals combined. The second largest number of pelts is from the striped skunk, and about equal numbers are taken from raccoons and badgers. The Beaver River, once a heavy producer of beaver, has a number of protected colonies.

A few farm ponds furnish good fishing for black bass, bluegill, and channel catfish. Some fishing is also to be had in the deeper holes of the Cimarron and Beaver Rivers as well as in a few spring-fed creeks. Common in the streams are carp, bullhead, green sunfish, warmouth bass, and channel catfish. Occasionally catches are made of bass, bluegill, and crappies that escaped from farm ponds.

Engineering Uses of Soils[6]

This soil survey report for Beaver County contains information that can be used by engineers to:

(1) Make soil and land-use studies that will aid in the selection and development of industrial, residential, and recreational sites.
(2) Make estimates of runoff characteristics for use in designing drainage structures and in planning dams and other structures for water and soil conservation.
(3) Make reconnaissance surveys of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed investigations of the selected locations.
(4) Locate probable sources of gravel, sand, caliche, and other construction materials.
(5) Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining the structures.
(6) Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.
(7) Supplement information obtained from other published maps and reports and from aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
(8) Develop other preliminary estimates for construction purposes pertinent to the particular area.

The mapping and the descriptive report are somewhat generalized and should be used only in planning more detailed field surveys. The more detailed field survey will, in turn, be used to determine the characteristics of the soil in place at the site of the proposed engineering construction.

[6] This section was written by R. L. BARTHOLIC, agricultural engineer, Soil Conservation Service.

The information in this part of the report will not eliminate the need for sampling and testing for design and construction of specific engineering work, but this information will serve as a guide for more efficient sampling and testing procedures.

Engineering Descriptions of Soils

In table 5 are brief descriptions of the soils mapped in Beaver County and estimates of their physical properties. The properties are those of a typical profile. The soils listed in table 5 are described more completely in the section "Descriptions of Soils."

In table 5 the texture of the significant layers of each soil mapped is given according to the classification of the United States Department of Agriculture (USDA). Also listed for each soil are corresponding classifications according to the Unified system and the system used by the American Association of State Highway Officials (AASHO).

The USDA classification is used by soil scientists and other agricultural workers. Soils are correlated and are named in this report according to this system.

The Unified classification was developed by the Corps of Engineers, U.S. Army. In this classification soils are identified according to their textural and plasticity qualities. SW is the symbol for well-graded sands and SP is for poorly graded sands. ML stands for silts having a liquid limit of 50 or less, and MH, for silts having a liquid limit greater than 50. CL is for clays having a low liquid limit, and CH, for clays having a high liquid limit.

The AASHO classification is used by highway engineers in classifying soils according to their engineering properties as determined by the performance of the soils in highways. In this system soil materials are classified in seven principal groups. The groups range from A–1, made up of gravelly soils of high bearing capacity, to A–7, made up of clay soils of low strength when wet.

The columns under "Percentage passing sieve" show the separtion between the coarse- and fine-grained soils and list the percentage of soil material that is smaller in diameter than the openings of the given screen.

Permeability is an estimate of the probable rate, in inches per hour, that water is transmitted by the soil.

Structure is listed according to agricultural terms for structure. Definitions of these terms describe the arrangement of primary soil particles into clusters, which are separated from adjoining masses by surfaces of weakness. These terms are defined in the Glossary.

By *dispersion* is meant the degree and rapidity that soil structure breaks down or slakes in water. A soil with high dispersion slakes readily. Generally, sand has high dispersion; a loam, or a mixture of sand, silt, and clay, has low dispersion; and a clay has high dispersion.

Shrink-swell potential refers to the change in volume that is a result of change in water content. Shrink-swell potential is expressed as low, moderate, high, and very high. Generally soils classed CH or A–7 have a high or very high shrink-swell potential, and soils classed SP or SM have a low shrink-swell potential. Randall clay and Pullman clay loam have a high or very high shrink-swell potential. Tivoli fine sand and Pratt loamy fine sand have a low shrink-swell potential.

TABLE 5.—*Brief descriptions of soils*

[For properties of complexes not listed (absence indicated by

Map symbol	Soil name	Soil description	Depth from surface (typical profile)	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ar	Alluvial and broken land	Exposed clay in draws and alluvium	0–12 12–44	Clay loam Clay loam	CL CL or CH	A–6 or A–7–6 A–6 or A–7–6
BpB	Bippus clay loam, 1 to 3 percent slopes.	Deep, granular soil on foot slopes of alluvial fans. Parent material from highly calcareous alluvial deposits.	0–44	Clay loam	CL	A–6 or A–7–6
Cn	Canadian fine sandy loam	Deep, fertile soil developed in sandy alluvial deposits on bottom lands.	0–38	Very fine sandy loam.	SM–SC or SC.	A–4 or A–2
CaA CaB	Carey silt loam, 0 to 1 percent slopes. Carey silt loam, 1 to 3 percent slopes.	Deep soil with silt loam surface layer and silty clay loam subsoil. Developed on uplands from red beds.	0–7 7–49+	Silt loam Silty clay loam.	ML–CL CL	A–4 A–6
DaA DaB	Dalhart fine sandy loam, 0 to 1 percent slopes. Dalhart fine sandy loam, 1 to 3 percent slopes.	Deep, sandy soil with about 10 inches of fine sandy loam on a friable sandy clay loam subsoil that takes in water well. Developed on uplands in medium-textured, wind-laid deposits.	0–10 10–36	Fine sandy loam. Sandy clay loam.	SM SC or SM–SC.	A–2 A–2 or A–4
La	Las Animas soils	Stratified silty clay loams over loamy fine sand. Developed from recent, sandy alluvial deposits that are subirrigated.	0–30 30–35	Silty clay Loamy fine sand.	CL or CH SM	A–7–5 or A–7–6. A–4
Lf	Likes loamy fine sand	Deep, weakly developed loamy fine sand on a very sandy subsoil. Developed on gentle, concave, slopes between sandy soils on uplands and streambeds from alluvium transported from higher slopes.	0–39	Loamy fine sand.	SM	A–2
Ln	Lincoln soils	Deep, structureless loamy sand in recent alluvial deposits that occupy channels in upland valleys.	0–45	Loamy fine sand.	SM	A–2
McB McC3	Mansic clay loam, 1 to 3 percent slopes. Mansic clay loam, 3 to 5 percent slopes, eroded.	Smooth, convex surface in a rolling erosional upland developed in calcareous, fine- and medium-textured sediments.	0–23 23–52	Clay loam Clay loam	ML–CL ML–CL	A–4 A–6
McC4	Mansic soils, severely eroded	Shallow, highly calcareous soils with about half of the subsoil exposed. Developed on uplands from medium-textured and hard caliche materials.	0–14	Loam	CL or ML	A–4 or A–6
MoB	Mansic-Otero complex, 1 to 3 percent slopes.	Calcareous, sandy soils mixed with soils having a moderately fine textured subsoil. Developed on undulating topography on erosional uplands.	----	----	----	----
MwB MwC3	Mansic-Woodward complex, 1 to 3 percent slopes. Mansic-Woodward complex, 3 to 5 percent slopes, eroded [2].	Deep, friable, upland soil. Loam topsoil on sandy clay loam subsoil. Developed in a thin mantle of outwash plains sediments, shallow over red beds.	0–24+ 24–32	Loam Sandy clay	CL CL	A–4 or A–6 A–6
MaB	Mansker clay loam, 1 to 3 percent slopes.	Highly calcareous soil with a subsoil high in lime; on a smooth convex slope.	0–11	Clay loam	CL	A–6 or A–7–6
MaC	Mansker clay loam, 3 to 5 percent slopes.	----	11–44	Clay loam	CL	A–6 or A–7–6

See footnotes at end of table.

and their estimated physical properties

dashes), refer to single soils that make up the complexes]

Percentage passing sieve—			Permeability	Structure	Available water	Reaction	Dispersion	Shrink-swell potential
No. 200 (0.74 mm.)	No. 10 (2.0 mm.)	No. 4 (4.7 mm.)						
			Inches per hour		*Inches per foot of depth*			
60–80	80–95	100	0. 05–0. 2	Prismatic	1. 6	Calcareous	Low	High.
55–65	75–85	90–100	. 2–0. 8	Granular	1. 6	Calcareous	Low	High.
60–75	95–100	100	. 2–0. 8	Granular to subangular blocky.	2. 0	Calcareous	Low	High.
25–35	95–100	100	1. 0–3. 0	Granular	1. 5	Calcareous	Medium	Medium.
85–95	90–100	95–100	1. 0–2. 5	Granular	1. 4	Noncalcareous	Medium	Low.
80–90	90–100	95–100	1. 0–2. 5	Crumb to prismatic	1. 5	Calcareous	Low	Medium.
30–40	85–100	100	2. 0–3. 0	Granular	1. 4	Noncalcareous	Medium	Medium.
35–45	100	100	1. 0–2. 0	Prismatic	1. 6	Noncalcareous	Medium	Medium.
85–95	95–100	100	. 05–0. 1	Granular	2. 0	Calcareous	Medium	High.
30–40	90–100	100	>. 05	Single grain	([1])	Calcareous	High	Low.
10–25	90–100	100	2. 5–5. 0	Granular	. 8	Calcareous	High	Low.
10–15	60–70	85–95	5–10	Single grain	. 05	Calcareous	High	Low.
80–90	100	100	----	Granular	----	Calcareous	----	
70–80	95–100	100	----	Granular to almost massive.	----	Strongly calcareous	----	
50–70	75–90	80–95	. 2–0. 8	Granular	1. 7	Calcareous	Low	Medium.
----	----	----	----	----	----	----	----	
60–70	90–100	95–100	1. 0–2. 5	Granular	1. 5	Noncalcareous	Low	Medium.
40–55	60–80	85–95	. 8–2. 5	Granular	1. 5	Calcareous	Low	Medium.
80–90	100	100	. 8–2. 0	Granular	1. 4	Calcareous	Medium	Medium to high.
80–90	90–100	100	. 2–0. 8	Massive	1. 7	Calcareous	Medium	Medium to high.

TABLE 5.—*Brief descriptions of soils*

[For properties of complexes not listed (absence indicated by

Map symbol	Soil name	Soil description	Depth from surface (typical profile)	Classification: USDA texture	Classification: Unified	Classification: AASHO
			Inches			
Mp	Mansker-Potter complex	Thin surface layer of loam and clay loam underlain by caliche or rock.				
	Mansker		0–11	Clay loam	CL	A–7–6 or A–6
			11–44	Clay loam	CL or CH	A–7–6 or A–6
	Potter		0–7	Clay loam	CL	A–6 or A–7–6
			7–24	Caliche	Caliche	Caliche
OtC3	Otero soils, 3 to 5 percent slopes, eroded.	Fine sandy loam over a calcareous loamy fine sand. Developed in coarse- and fine-textured wind-laid deposits.	0–12	Fine sandy loam.	SM–SC or SC.	A–2
			12–51+	Loamy fine sand.	SM	A–2
Om	Otero-Mansker complex	Mixture of deep, sandy, and shallow soils on uplands. Otero soils make up 80 percent of the complex, Mansker 15 percent, and other soils 5 percent.				
OpD	Otero-Pratt fine sandy loams, 3 to 12 percent slopes.	Mostly fine sandy loam, but partly loamy fine sand on caliche subsoil. Narrow bands of Mansker-Potter complex included. Otero soils make up 55 percent of the complex, Pratt 35 percent, and Mansker-Potter complex 10 percent.				
PfB	Pratt fine sandy loam, undulating.	Deep fine sandy loam on billowy uplands.	0–40	Fine sandy loam.	SM–SC or SC.	A–2–3 or A–2
Pr Pt	Pratt loamy fine sand Pratt-Tivoli loamy fine sands.[3]	Deep loamy fine sand that is slightly cohesive in the subsoil. Developed in deep sands deposited by wind.	0–42	Loamy fine sand.	SM	A–2
Pm	Pullman clay loam	Deep silty clay loam to a depth of 6 inches on a coarse, blocky clay subsoil that extends to 30 inches.	0–7	Silty clay	CL	A–6
			7–30	Clay	CH or MH	A–7–6
Ra	Randall clay	Heavy deep clay to a depth of more than 48 inches and intermittent lakes.	0–50+	Clay	CH or MH	A–7–5 or A–7–6.
RcA	Richfield clay loam, 0 to 1 percent slopes.	Granular clay loam to a depth of 6 inches and overlying a compact silty clay loam that extends to 35 inches on uplands.	0–7	Clay loam	CL	A–6
			7–35	Clay loam	CL	A–7–6
RcB	Richfield clay loam, 1 to 3 percent slopes.	Deep soil with 12 inches of clay loam on a blocky clay loam subsoil that extends to a depth of 62 inches on uplands.	0–10	Clay loam	CL	A–4
			10–62	Clay loam	CL	A–6 or A–7–6
RmC	Richfield-Mansic clay loams, 3 to 5 percent slopes.[4]	A complex of moderately fine textured soils that developed in loamy deposits on moderate slopes.				
Rt	Richfield loam, thick surface	Deep, level silt loam on compact clay loam subsoil that takes water slowly. Developed on uplands from fine- and medium-textured, calcareous material deposited by wind.	0–12	Silt loam	ML or CL	A–4
			12–30	Clay loam	CL	A–6 or A–7–6
Sp	Spur soils	Deep clay loam, nearly level on bottom lands along rivers and large creeks. Developed from fine- and medium-textured alluvium.	0–24	Clay loam	CL or CH	A–6 or A–7–6
			24–43+	Sandy clay loam.	CL or SC	A–6 or A–7–6

See footnotes at end of table.

and their estimated physical properties—Continued

dashes), refer to single soils that make up the complexes]

Percentage passing sieve—			Permeability	Structure	Available water	Reaction	Disposition	Shrink-swell potential
No. 200 (0.74 mm.)	No. 10 (2.0 mm.)	No. 4 (4.7 mm.)						
			Inches per hour		*Inches per foot of depth*			
-----	-----	-----	-----	-----	-----	-----	-----	
70–80	85–95	90–100	.2–0.8	Granular	1.6	Calcareous	Low	High.
55–65	75–85	90–100	.2–0.8	Granular	1.6	Calcareous	Low	High.
55–65	80–90	95–100	.8–1.5	Granular	.8	Calcareous	Low	High.
-----	-----	-----	-----	-----	-----	-----	-----	
25–35	90–100	100	2.0–3.0	Granular	1.2	Calcareous	Medium	Medium.
15–20	90–100	100	3–5	Single grain	.9	Calcareous	High	Low.
-----	-----	-----	-----	-----	-----	-----	-----	
-----	-----	-----	-----	-----	-----	-----	-----	
25–35	95–100	100	2.0–3.0	Granular	1.4	Noncalcareous	Medium	Medium.
15–25	95–100	100	3.5–5.0	Granular	.8	Noncalcareous	High	Low.
80–95	100	100	.05–0.2	Granular	2.0	Noncalcareous	Medium	Medium.
80–97	100	100	.08–0.15	Blocky	2.0	Noncalcareous	Low	High.
70–90	100	100	>.05	Massive	2.0	Noncalcareous	Low	Very high.
85–97	100	100	.2–0.8	Granular	2.0	Noncalcareous	Medium	Medium.
85–98	100	100	.2–0.8	Subangular blocky	2.0	Noncalcareous	Medium	Medium.
60–80	95–100	100	.05–0.2	Granular	1.7	Calcareous	Low	Low to medium.
80–95	95–100	100	.05–0.2	Blocky	1.7	Calcareous	Low	Medium to high.
-----	-----	-----	-----	-----	-----	-----	-----	
65–75	95–100	100	.8–1.5	Granular	1.4	Noncalcareous	Medium	Medium.
65–75	95–100	100	.2–0.8	Subangular blocky	1.7	Noncalcareous	Low	High.
60–80	80–95	100	.8–1.7	Granular	2.0	Calcareous	Low	High.
40–55	60–80	95–100	.8–1.7	Granular	1.7	Calcareous	Medium	Medium.

TABLE 5.—*Brief descriptions of soils*

[For properties of complexes not listed (absence indicated by

Map symbol	Soil name	Soil description	Depth from surface (typical profile)	Classification		
				USDA texture	Unified	AASHO
			Inches			
Tv	Tivoli fine sand	Deep, loose, slightly developed loamy fine sand many feet deep. Developed in loose sands that were deposited by wind.	0–60+	Loamy fine sand.	SP to SM	A–2 or A–3
Ac	Active dunes.					
UsA	Ulysses silt loam, 0 to 1 percent slopes.	Deep silt loam with friable silty clay loam subsoil. Parent material fine-textured calcareous material on uplands.	0–10	Silt loam	ML or CL	A–4
UsB	Ulysses silt loam, 1 to 3 percent slopes.		10–65	Silt loam	CL	A–6
UsC	Ulysses silt loam. 3 to 5 percent slopes.					
Ur	Ulysses-Richfield complex	Medium and moderately fine textured soils on gently undulating topography.				
Ve	Vernon loams	Clay loam surface layer on partly weathered clay and shale subsoil. Developed in red-bed shale.	0–16	Sandy clay loam.	ML–CL	A–6
Wm	Woodward-Mansic complex	A complex of loamy soils; some developed in red-bed material and some in loamy outwash sediments.				

[1] Unlimited amount. [2] Woodward part of Mansic-Woodward complex, 3 to 5 percent slopes, eroded.

and their estimated physical properties—Continued

dashes), refer to single soils that make up the complexes]

Percentage passing sieve—			Permeability	Structure	Available water	Reaction	Disposition	Shrink-swell potential
No. 200 (0.74 mm.)	No. 10 (2.0 mm.)	No. 4 (4.7 mm.)						
			Inches per hour		*Inches per foot of depth*			
3–10	95–100	100	5–10	Single grain	.05	Noncalcareous	High	Low.
70–85	100	100	.8–1.5	Granular	1.7	Calcareous	Medium	Medium.
80–90	100	100	.8–1.7	Granular	2.0	Calcareous	Medium	Medium.
---	---	---	---	---	---	---	---	
85–100	100	100	.05–0.2	Massive	1.4	Calcareous	Low	Medium.
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[3] Pratt part of Pratt-Tivoli loamy fine sands. [4] Richfield part of Richfield-Mansic clay loams, 3 to 5 percent slopes.

TABLE 6.—*Engineering*

[Dashed lines indicate that rating has not been assigned to soil,

Soil series and map symbols	Suitability of soil material for—		Suitability as source of—	
	Road subgrade	Road fill	Topsoil	Sand
Active dunes (Ac)	Poor	Poor	Poor	Good
Alluvial and broken land (Ar)	Poor	Poor to fair	Good	Poor
Bippus (BpB)	Poor	Poor to fair	Good to depth of 16 to 18 inches	Not suitable
Canadian (Cn)	Good	Fair	Good to depth of about 6 inches	Not suitable
Carey (CaA, CaB)	Fair	Good	Good to depth of 7 to 9 inches	Not suitable
Dalhart (DaA, DaB)	Good	Good	Good to depth of 4 to 6 inches	Not suitable
Las Animas (La)	Poor in upper 1½ to 3 feet; fair below.	Poor to fair in upper 1½ to 3 feet; fair below.	Good to depth of 4 to 6 inches	Poor
Likes (Lf)	Poor	Poor	Poor	Good
Lincoln (Ln)	Poor	Poor	Poor	Good
Mansic (McB, McC3)	Good	Good	Good to depth of 4 to 6 inches	Not suitable
Mansic soils, severely eroded (McC4).	Good	Good	Poor	----
Mansic-Otero[1] (MoB)	Fair	Poor	Poor	Good
Mansic-Woodward[2] (MwB, MwC3)	Good	Fair to good	Good to depth of 6 to 8 inches	Poor to fair; gravel spots.
Mansker (MaB, MaC)	Poor	Poor to fair	Fair	----
Mansker-Potter[3] (Mp)	Poor	Poor to fair	Good to depth of 0 to 5 inches	See remarks
Otero (eroded) (OtC3)	Fair	Poor	Poor	Good
Otero-Mansker (Om)	Fair	Poor	Good	Poor
Otero-Pratt (OpD)	Fair	Poor	Poor	Good
Pratt (undulating) (PfB)	Good	Good	Good to depth of 6 to 12 inches	Good
Pratt (Pr)	Fair	Poor	Poor	Good
Pullman (Pm)	Poor	Poor to fair	Good to depth of 4 to 6 inches	Not suitable
Pratt-Tivoli (Pt)	Poor	Poor	Poor	Good
Randall (Ra)	Poor	Poor to fair	Poor	Not suitable
Richfield (RcA, RcB, Rt)	Poor	Poor to fair	Good to depth of 5 to 15 inches	Not suitable
Richfield-Mansic[4] (RmC)	Poor	Fair	Good to depth of 12 inches	Not suitable
Spur (Sp)	Poor	Poor to fair	Good to depth of 10 to 15 inches	Not suitable
Tivoli (Tv)	Poor	Poor	Poor	Good
Ulysses (UsA, UsB, UsC)	Good	Good	Good to depth of 4 to 6 inches	Not suitable
Ulysses-Richfield (Ur)	Fair	Fair	Good to depth of 4 to 6 inches	Not suitable
Vernon (Ve)	Good	Fair	Poor	Not suitable
Woodward-Mansic (Wm)	Good	Good	Good to depth of 4 to 6 inches	Not suitable; gravel spots.

[1] Otero part. [2] Woodward part. [3] Potter part. [4] Richfield part.

interpretation of soils

because of variability of properties or for other reasons]

Soil features affecting farm ponds: Reservoir	Soil features affecting farm ponds: Embankment	Agricultural drainage	Suitability for—: Land leveling for irrigation	Suitability for—: Irrigation ditches	Suitability for—: Borders for irrigation	Suitability for—: Holdover reservoir	Suitability for—: Terraces and diversions	Suitability for—: Waterways	Remarks
Pervious	Unstable								
Impervious	Stable					Good	Good	Good	
Impervious	Stable	Fair to good	Good	Fair to good	Good	Good	Good	Good	
Fairly impervious	Fairly stable	Good	Good	Poor to fair	Poor	Poor	Poor	Good	
Impervious	Stable	Good	Good	Fair to good	Good	Good	Good	Good	
Impervious	Stable	Good	Good	Poor	Good	Fair	Fair	Good	
Pervious	Unstable	Poor	Poor			Poor		Good	High water table.
Pervious	Unstable					Poor	Fair	Poor	Diversions only.
Pervious	Unstable					Poor			
Impervious	Stable	Good	Fair	Good	Good	Good	Good	Good	Gravel spots.
Impervious	Stable					Good			Gravel spots.
Pervious	Unstable					Poor	Poor	Poor	
Impervious	Stable	Good	Poor	Fair		Good	Good	Fair	Local lenses of gravel.
Impervious	Stable	Good				Good	Good	Good	
Pervious	Fairly stable					Poor	Good	Poor	Good source of caliche. Diversions only.
Pervious	Unstable					Poor	Poor	Poor	
Fairly impervious.	Fairly stable					Poor	Poor	Poor	
Pervious	Unstable					Poor	Poor	Poor	
Pervious	Good	Good	Good	Poor	Poor	Poor	Poor	Fair	
Pervious	Unstable	Good				Poor	Poor	Fair	
Impervious	Stable	Poor	Good	Good	Fair	Good	Good	Good	
Pervious	Unstable								
Impervious	Unstable	Poor	Poor	Good	Poor	Good			
Impervious	Fairly stable	Fair	Good	Good	Good	Good	Good	Good	
Impervious	Unstable	Poor	Fair	Fair	Poor	Good	Good	Good	Cracks when dry.
Impervious	Unstable	Fair	Good	Good	Good	Good	Good	Good	
Pervious	Unstable								
Impervious	Stable	Fair	Good	Good	Good	Fair	Good	Good	
Impervious	Stable	Good	Fair	Good	Good	Good	Good	Good	
Fairly impervious.	Fairly stable					Poor		Fair	
Impervious	Stable	Good	Fair	Good	Good	Good	Good	Good	

TABLE 7.—*Engineering*

[Dashes indicate that sample

Map symbol	Soil name	Sample number	Laboratory number	Depth	Horizon	AASHO classification	Unified classification
				Inches			
CaB	Carey silt loam, 1 to 3 percent slopes (modal).	59-OK-4-4-1	SO-220	0 to 7	A_{1p}	A-4(8)	ML-CL
		59-OK-4-4-2	SO-221	7 to 14	B_1	A-6(11)	CL
				14 to 30			
		59-OK-4-4-3	SO-222	30 to 49	C_{ca}	A-6(9)	CL
CaB	Carey silt loam, 1 to 3 percent slopes (nonmodal).	59-OK-4-3-1	SO-216	0 to 7	A_p	A-4(8)	ML-CL
				7 to 14			
		59-OK-4-3-2	SO-217	14 to 21	B_2	A-7-6(13)	CL
		59-OK-4-3-3	SO-218	21 to 39	B_3	A-7-6(13)	ML-CL
		59-OK-4-3-4	SO-219	39 to 54	C	A-7-6(12)	CL
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes (modal).	59-OK-4-9-1	SO-234	0 to 10	A_1	A-2-4(0)	SM
		59-OK-4-9-2	SO-235	10 to 18	B_1	A-4(1)	SC
				18 to 30			
		59-OK-4-9-3	SO-236	30 to 43	C_{ca}	A-2-4(0)	SM-SC
La	Las Animas soils (nonmodal)	59-OK-4-12-1	SO-243	0 to 22	A	A-7-6(15)	ML-CL
		59-OK-4-12-2	SO-244	22 to 30	C_1	A-7-5(20)	MH-CH
		59-OK-4-12-3	SO-245	30 to 36		A-4(1)	SM-SC
McC3	Mansic clay loam, 3 to 5 percent slopes, eroded (modal).[2]	59-OK-4-5-1	SO-223	0 to 7	A_1	A-4(8)	ML-CL
		59-OK-4-5-2	SO-224	7 to 14	AC	A-4(8)	ML-CL
				14 to 20			
		59-OK-4-5-3	SO-225	20 to 38	C_{ca}	A-6(8)	CL
PfB	Pratt fine sandy loam, undulating (modal).	59-OK-4-10-1	SO-237	0 to 6	A_1	A-2-4(0)	SM
		59-OK-4-10-2	SO-238	6 to 18	C_1	A-2-4(0)	SM
				18 to 30			
		59-OK-4-10-3	SO-239	30 to 48	C	A-2-4(0)	SM
PfB	Pratt fine sandy loam, undulating (nonmodal).	59-OK-4-15-1	SO-252	0 to 8	A_1	A-4(1)	SM-SC
		59-OK-4-15-2	SO-253	8 to 19	B_2	A-4(3)	CL
		59-OK-4-15-3	SO-254	19 to 39	C	A-2-4(0)	SM
Pr	Pratt loamy fine sand (modal)	59-OK-4-8-1	SO-232	0 to 10	A	A-2-4(0)	SM
				10 to 30			
		59-OK-4-8-2	SO-233	30 to 38	C	A-2-4(0)	SM
Pm	Pullman clay loam (modal)	59-OK-4-6-1	SO-226	0 to 7	A_1	A-6(10)	ML-CL
		59-OK-4-6-2	SO-227	7 to 21	B_2	A-7-6(17)	CH
				21 to 48			
		59-OK-4-6-3	SO-228	48 to 65	D	A-7-6(17)	CH
RmC	Richfield-Mansic clay loams, 3 to 5 percent slopes (modal).[2]	59-OK-4-11-1	SO-240	0 to 10	A_1	A-4(8)	ML-CL
		59-OK-4-11-2	SO-241	10 to 20	B_2	A-7-6(16)	CL
				20 to 42			
		59-OK-4-11-3	SO-242	42 to 72	C	A-6(11)	CL
RcA	Richfield clay loam, 0 to 1 percent slopes (modal).	59-OK-4-7-1	SO-229	0 to 7	A_p	A-6(10)	CL
		59-OK-4-7-2	SO-230	7 to 21	B_2	A-7-6(17)	MH-CH
				21 to 36			
		59-OK-4-7-3	SO-231	36 to 53	C_{ca}	A-7-6(16)	CL
UsB	Ulysses silt loam, 1 to 3 percent slopes (nonmodal).	59-OK-4-13-1	SO-246	0 to 9	A_1	A-6(10)	ML-CL
		59-OK-4-13-2	SO-247	9 to 28	B_2	A-7-6(16)	MH-CH
		59-OK-4-13-3	SO-248	28 to 40	C_{ca}	A-7-6(13)	ML-CL
UsC	Ulysses silt loam, 3 to 5 percent slopes (modal).	59-OK-4-14-1	SO-249	0 to 10	A_1	A-4 (8)	ML-CL
		59-OK-4-14-2	SO-250	10 to 50	A_c	A-6 (11)	CL
		59-OK-4-14-3	SO-251	50 to 65	C_{ca}	A-6 (12)	CL
Ve	Vernon loams (modal)	59-OK-4-16-1	SO-255	0 to 6	A	A-6(9)	ML-CL
		59-OK-4-16-2	SO-256	6 to 16	C	A-6(9)	ML-CL
		59-OK-4-16-3	SO-257	16 to 65	D	A-5(8)	ML

[1] NP stands for nonplastic.
[2] Richfield part; profile from area of native pasture that has no erosion to slight erosion.

test data

of horizon was not tested]

Liquid limit	Plastic limit	Shrinkage		Vol. change from FME	Percentage passing sieve—				Percentage smaller than—		
		Limit	Ratio		No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.
31	22	19	1. 81	21	100	99	97	86	75	25	22
39	22	16	1. 83	36	100	99	98	90	80	35	30
29	17	15	1. 90	27	100	98	95	84	69	41	32
31	21	17	1. 79	22	100	99	98	88	75	24	20
44	23	15	1. 89	48	100	99	98	96	90	37	34
46	25	13	1. 95	54	100	99	98	95	90	42	37
42	23	17	1. 82	37	100	98	97	91	86	47	40
NP[1]	NP[1]	NP[1]	NP[1]	NP[1]	100	96	70	24	15	7	6
27	18	17	1. 81	14	100	98	86	42	35	19	12
20	16	15	1. 82	5	100	96	77	34	26	17	13
50	27	17	1. 81	46	100	100	99	95	92	55	45
67	33	13	1. 92	74	100	100	99	94	92	62	52
25	19	18	1. 72	7	100	95	84	39	25	17	14
34	24	22	1. 65	14	100	93	90	83	75	17	14
33	24	22	1. 69	19	100	96	93	84	73	21	20
33	21	17	1. 79	25	100	89	83	72	63	23	20
NP[1]	NP[1]	NP[1]	NP[1]	NP[1]	100	99	92	30	20	7	6
21	18	17	1. 77	4	100	99	91	30	20	12	11
19	17	16	1. 82	3	100	98	83	26	20	12	11
21	17	16	1. 82	8	100	98	83	40	30	17	14
27	17	15	1. 84	14	100	99	89	51	39	22	20
19	16	16	1. 81	4	100	96	75	28	22	16	13
NP[1]	NP[1]	NP[1]	NP[1]	NP[1]	100	97	78	24	19	10	9
NP[1]	NP[1]	NP[1]	NP[1]	NP[1]	100	98	78	21	15	10	9
38	23	18	1. 74	27	100	100	99	94	85	32	27
53	26	13	1. 93	55	100	100	100	97	90	44	40
52	25	14	1. 89	51	100	99	99	97	94	45	37
29	21	18	1. 77	15	100	96	94	77	72	20	19
48	25	13	1. 93	53	100	97	96	91	85	44	39
40	23	19	1. 75	29	100	94	91	82	75	37	34
35	21	18	1. 73	23	100	99	99	97	92	28	25
53	28	13	1. 91	46	100	100	100	98	94	43	33
49	24	14	1. 90	50	100	99	99	96	90	43	36
39	25	18	1. 78	30	100	99	99	91	82	31	27
51	27	15	1. 86	51	100	100	98	97	94	45	38
45	25	14	1. 87	47	100	100	100	93	87	37	34
30	21	20	1. 71	12	100	99	98	82	65	19	15
39	22	14	1. 90	37	100	99	98	88	80	38	31
40	21	15	1. 89	33	100	99	98	85	77	32	29
37	25	21	1. 66	16	100	97	94	88	83	24	11
37	24	19	1. 78	23	100	100	99	98	94	43	25
41	31	24	1. 59	18	100	97	91	71	67	17	14

Engineering Interpretation of Soils

In table 6 are listed, for each soil series, ratings of suitability for construction materials and for agricultural structures. Also listed are soil features that affect the construction and maintenance of reservoirs and embankments for farm ponds. The interpretations in table 6 were made after evaluating the data in table 7 and other available test data, and after considering the performance of soils in the field. Other information useful in engineering, such as the location of soils suitable for road-fill material, can be obtained from the soil map. The section "Descriptions of Soils" also contains information helpful in engineering work.

Soil Test Data

In table 7 are data from the tests of soil material from 14 profiles in the county. These profiles are described verbally later in this subsection. The profiles are designated as modal or nonmodal. A modal profile is typical of the soil as it occurs in the county, and a nonmodal profile has significant variations from the modal. Laboratory tests reported in table 7 were made by the Oklahoma Department of Highways, Materials and Research Department, in accordance with standard procedures of the American Association of State Highway Officials.

The engineering soil classifications are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. Mechanical analyses were made by the combined sieve and hydrometer methods. Percentage of clay obtained in this test by the hydrometer is not used in determining soil textural classes.

The tests for *liquid limit* and *plastic limit* measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from solid to semisolid and then to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material passes from plastic to liquid. The *plasticity index* is the numerical difference between the liquid limit and plastic limit. It indicates the range of moisture content within which a soil material is plastic.

As moisture leaves a soil, the soil decreases in volume in direct proportion to the loss in moisture, until a point is reached where shrinkage stops although additional moisture is removed. The moisture content where shrinkage stops is called the *shrinkage limit.*

Since clay is the major soil fraction that causes shrinkage, the shrinkage limit of a soil is a general index of clay content and will, in general, decrease with increases in clay content. The shrinkage limits of sand devoid of clay show a test result that is close to the liquid limit and is considered insignificant. Sands containing some silt and clay have a shrinkage limit of about 14 to 25, and the shrinkage limit of clays ranges from about 6 to 14. The load-carrying capacity of a soil is at a maximum when its moisture content is at or below the shrinkage limit. Sands do not follow this rule since they will have a uniform load-carrying capacity with a considerable range in moisture content, providing they are confined.

The *shrinkage ratio* is the volume change resulting from the drying of a soil material, divided by the loss of moisture caused by drying. The ratio is expressed numerically.

Volume change is the change in volume that takes place in a soil when it dries from a given moisture content to a point where no further shrinkage takes place.

Field moisture equivalent (FME) is the minimum moisture content at which a smooth surface of soil will absorb no more water in 30 seconds when the water is added in individual drops. It is the moisture content required to fill all the pores in sands, and to approach saturation in cohesive soils.

According to AASHO procedure, a mechanical analysis was made to obtain the percentages of the size classes listed in table 7. The results of this procedure frequently differ from the results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the ASSHO procedure, the fine material is determined by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is determined by the pipette method and the material coarser than 2 millimeters in diameter is excluded from the calculations of the grain-size fractions. The data in table 7 are not suitable for use in naming textural classes for soils.

Profile descriptions of soils tested

Described in the following pages are the profiles of the soils listed in table 7 and tested for properties important in engineering.

CAREY SILT LOAM, 1 TO 3 PERCENT SLOPES (MODAL)

This soil is on convex slopes in the uplands. It formed on Permian red beds of clayey shale and sandstone. The profile described is in a cultivated field on the southern slope of the Beaver River (50 feet south and 1,050 feet west of the northwest corner of NW¼ sec. 27, T. 4 N., R. 23 E.):

A_{1p} 0 to 7 inches, dark reddish-brown (5YR 3/2, moist) silty clay loam; fine, granular structure; friable; porous; noncalcareous.

B_1 7 to 14 inches, dark reddish-brown (5YR 3/3, moist) silty clay loam; moderate, medium, granular and weak, subangular blocky structure; porous; few concretions of calcium carbonate in lower 2 inches.

B_2 14 to 30 inches, dark reddish-brown (2.5YR 3/4, moist) clay loam; weak, medium, blocky and coarse, columnar structure; thin, patchy clay skins; segregated soft concretions of lime make up less than 1 percent of horizon; friable when moist.

C_{ca} 30 to 49 inches, red (2.5YR 4/6, moist) light silty clay loam; moderate, fine, granular structure; porous; friable when moist; calcareous.

CAREY SILT LOAM, 1 TO 3 PERCENT SLOPES (NONMODAL)

This soil is on convex slopes on gently sloping uplands. It formed in Permian red beds of shale and sandstone. The profile described has a subsoil that is more clayey than is typical of Carey silt loam. This profile is in a cultivated field on the southern slope of the Beaver River

(75 feet south and 1,150 feet west of the northeast corner of NE¼ sec. 36, T. 4 N., R. 23 E.) :

A_p 0 to 7 inches, dark-brown (10YR 3/3, moist) silt loam; weak, fine, granular structure; soft when dry and friable when moist; noncalcareous; gradual boundary.

B_1 7 to 14 inches, dark-brown (7.5YR 3/2, moist) silty clay loam; moderate, medium, granular structure; indistinct, intermittent clay skins; very friable when moist.

B_2 14 to 21 inches, dark-brown (7.5YR 4/4, moist) clay loam; moderate, subangular blocky to strong, granular structure; distinct clay skins; very friable when moist; noncalcareous; clear boundary.

B_3 21 to 39 inches, dark-brown (7.5YR 4/4, moist) clay loam; moderate, medium, granular structure; calcareous; soft segregated lime makes up less than 1 percent of horizon; porous; permeable; very friable when moist; gradual boundary.

C 39 to 54 inches +, yellowish-red (5YR 4/8, moist) silt loam; calcium carbonate makes up between 5 and 10 percent of horizon.

DALHART FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES (MODAL)

This soil is on the gently undulating High Plains. It formed in medium- and fine-textured eolian deposits. The profile described is in a cultivated field (600 feet north and 50 feet east of the southwest corner of SW¼ sec. 11, T. 5 N., R. 22 E.) :

A_{1p} 0 to 6 inches, yellowish-brown (10YR 5/6, moist) fine sandy loam and stratified (winnowed layer on the surface) loamy fine sand; single grain (structureless); noncalcareous.

A_1 6 to 10 inches, dark-brown (10YR 3/3, moist) fine sandy loam; moderate, fine and medium, granular structure; friable; noncalcareous.

B_2 10 to 18 inches, brown (7.5YR 4/4, moist) sandy clay loam; friable; compound moderate, prismatic and moderate, medium, granular structure; noncalcareous; very hard when dry and friable when moist.

B_3 18 to 30 inches, strong-brown (7.5YR 5/6, moist) sandy clay loam; compound weak, coarse, granular and weak, fine, granular structure; very porous and open; noncalcareous.

C_{ca} 30 to 43 inches, reddish-yellow (7.5YR 6/6, moist) fine sandy loam; concretions of calcareous calcium make up less than 1 percent of horizon; porous; weak, fine, granular structure.

C 43 to 48 inches, reddish-yellow (7.5YR 7/6, moist) loamy fine sand; massive (structureless); porous; less segregated lime than in C_{ca} horizon.

LAS ANIMAS SOILS (NONMODAL)

Las Animas soils developed from recent deposits of sandy alluvium. They are in poorly drained, nearly level to gently undulating areas near rivers or flowing creeks. The profile described is in a native pasture on the prairie (200 feet north and 150 feet east of the Beaver River bridge in SW¼ of sec. 7, T. 4 N., R. 24 E.) :

A_1 0 to 22 inches, very dark brown (10YR 2/2, moist) clay loam; medium to fine, granular structure; calcareous.

AC 22 to 30 inches, dark-brown (10YR 3/3, moist) clay loam; medium to fine, granular structure; calcareous.

C 30 to 36 inches +, dark grayish-brown (10YR 4/2) loamy sand; single grain (structureless); thin lenses of stratified sandy clay loam mottled with yellowish brown; calcareous.

MANSIC CLAY LOAM, 3 TO 5 PERCENT SLOPES, ERODED (MODAL)

This soil is on smooth, convex slopes on rolling upland that is susceptible to erosion. It formed in calcareous, fine- and medium-textured sediments. The profile described is west of a road in native pasture (920 feet south of northeast corner of sec. 13, T. 3 N., R. 23 E.) :

A_1 0 to 7 inches, very dark grayish-brown (10YR 3/2, moist) clay loam; strong, medium to fine, granular structure; many worm casts; friable; porous; permeable; calcareous.

AC 7 to 14 inches, dark grayish-brown (10YR 4/2, dry) clay loam; strong, medium to fine, granular structure; many worm casts; friable; calcareous.

14 to 20 inches, layer not sampled but is similar to layer above.

C_{ca} 20 to 38 inches, pale-brown (10YR 6/3, dry) clay loam; compound weak, prismatic and strong, medium to fine, granular structure; porous; calcareous.

38 to 42 inches, layer not sampled but is similar to layer above.

C 42 to 50 inches, light-brown (7.5YR 6/4, dry) clay loam; porous; massive (structureless); friable; calcareous; contains fine and medium sand.

PRATT FINE SANDY LOAM, UNDULATING (MODAL)

This soil is in a billowy area that has slopes of 2 to 6 percent. It formed in sandy eolian deposits that are between billowy Pratt loamy fine sand and the smoother, gently undulating Dalhart soils. The profile described is west of a road in a cultivated field (260 feet north of southeast corner of sec. 16, T. 6 N., R. 22 E.) :

A_1 0 to 6 inches, dark-brown (10YR 4/3, moist) fine sandy loam; weak, fine and medium, granular structure; friable; noncalcareous.

C_1 6 to 18 inches, yellowish-brown (10YR 5/4, moist) fine sandy loam; friable; slightly more coherent than horizon above; weak, fine, granular structure; noncalcareous.

18 to 30 inches, layer not sampled but is similar to layer above.

C_2 30 to 48 inches, yellowish-brown (10YR 5/4, moist) loamy fine sand; single grain (structureless); noncalcareous.

PRATT FINE SANDY LOAM, UNDULATING (NONMODAL)

This soil is in a billowy area that has slopes of 2 to 6 percent. It has a finer textured subsoil than is typical of Pratt fine sandy loam, undulating, in this county. The profile described is in a pit in a cultivated field (300 feet north of southeast corner of NW¼ sec. 11, T. 5 N., R. 24 E.) :

A_1 0 to 8 inches, yellowish-brown (10YR 5/4, moist) fine sandy loam; weak, fine, granular structure; friable; noncalcareous.

B_2 8 to 19 inches, yellowish-brown (10YR 5/4, moist) light sandy clay loam; porous; moderate, medium, granular structure; calcareous.

C 19 to 39 inches +, yellowish-brown (10YR 5/4, moist) fine sand; weak, granular structure or single grain (structureless); calcareous.

PRATT LOAMY FINE SAND (MODAL)

This soil is in undulating and billowy topography that has slopes of 2 to 6 percent. It formed in sandy eolian deposits along the northern slopes of the Beaver and Cimarron Rivers, between the more sandy dunes near the rivers and the irregular slopes to the north. It is in native range and has a fair cover of sand sage and short and mid grasses. The profile described is in a road cut

(north of a road, 1,320 feet east of southwest corner of SW¼ sec. 9, T. 5 N., R. 23 E.):

A_1 0 to 10 inches, yellowish-brown (10YR 5/4, moist) loamy fine sand stratified with fine sandy loam; single grain (structureless) to weak, medium to fine, granular structure; noncalcareous.

C_1 10 to 30 inches, yellowish-brown (10YR 5/4.5, moist) loamy fine sand; more cohesive than A_1 layer; noncalcareous.

C_2 30 to 38 inches, yellowish-brown (10YR 5/6, moist) loamy fine sand; weak, medium, granular structure.

PULLMAN CLAY LOAM (MODAL)

This soil is on nearly level uplands that have slopes of 0 to 1 percent. It formed in moderately fine textured loess on the High Plains. The profile described is north of a road in a cultivated field (660 feet north and 69 feet east of southwest corner of SW¼ sec. 34, T. 1 N., R. 22 E.):

A_1 0 to 7 inches, very dark grayish-brown (10YR 3/2, moist) clay loam; weak, medium to fine, granular structure; friable when moist, hard when dry; noncalcareous; numerous roots; abrupt boundary.

B_2 7 to 21 inches, dark-brown (10YR 3/3, moist) clay; compound strong, coarse, blocky crushing to weak, granular structure; clay skins continuous; noncalcareous; roots between peds; very firm when moist, very hard when dry; abrupt boundary.

B_3 21 to 36 inches, dark yellowish-brown (10YR 4/4, moist) clay; porous; medium and coarse, blocky structure; calcareous; clay skins; porous; friable when moist, slightly hard when dry; calcareous, with segregated lime over surface of peds.

C_u 36 to 48 inches, dark grayish-brown (10YR 4/2, moist) silty clay loam; weak, medium, granular structure; highly calcareous; pseudo mycelium; very friable; lime films.

D 48 to 65 inches, strong-brown (7.5YR 5/6, moist) silty clay loam; slightly calcareous; porous; massive (structureless).

RICHFIELD CLAY LOAM, 0 TO 1 PERCENT SLOPES (MODAL)

This soil is on well-drained, nearly level uplands of the High Plains. Its parent material is moderately fine textured, calcareous loess. The profile described is east of a road in a cultivated field (100 feet east and 50 feet south of northwest corner of SW¼ sec. 9, T. 1 N., R. 23 E.):

A_p 0 to 7 inches, very dark grayish-brown (10YR 3/2, moist) clay loam; friable; medium and fine, granular structure; noncalcareous.

B_2 7 to 21 inches, dark-brown (10YR 3/3, moist) silty clay loam; strong, medium to fine, subangular blocky structure; noncalcareous; clay skins pronounced but not continuous.

B_3 21 to 36 inches, brown (10YR 5/3, moist) silty clay loam; weak, medium and coarse, blocky structure; few patchy clay skins; porous; calcareous.

C_{ca} 36 to 53 inches +, brown (10YR 5/3, moist) silty clay loam; massive (structureless); few segregated concretions of lime; calcareous.

RICHFIELD-MANSIC CLAY LOAMS, 3 TO 5 PERCENT SLOPES (MODAL)

These soils are on moderately sloping uplands that have convex slopes of 3 to 5 percent. They developed in medium-textured, calcareous sediments that washed from the upper parts of the High Plains to the rolling, erosive fringes of these plains. The profile that follows is of the Richfield part of this complex and is in a pit in a cultivated field (1,100 feet east and 50 feet north of southwest corner of SW¼ sec. 6, T. 2 N., R. 26 E.):

A_1 0 to 10 inches, dark-brown (10YR 3/3, moist) clay loam; moderate, medium, granular structure; friable; noncalcareous.

B_2 10 to 20 inches, brown (10YR 4/3, moist) heavy clay loam; moderate, medium, subangular blocky structure; thin, continuous clay films on the outside of peds; noncalcareous in upper 12 inches and calcareous below.

BC_{ca} 20 to 42 inches, brown (10YR 5/3, moist) clay loam that contains scattered, soft concretions of lime; moderate, medium to coarse, blocky structure; thin clay skins on peds; friable; strongly calcareous.

C 42 to 72 inches, light-brown (7.5YR 6/4, moist), moderately compact, calcareous clay loam stratified with beds that are sandier and with beds containing more clay than the clay loam.

ULYSSES SILT LOAM, 1 TO 3 PERCENT SLOPES (NONMODAL)

This soil is on undulating uplands on slightly convex slopes. It developed on the High Plains in fine-textured, silty loess. The subsoil of the profile described is finer textured than that of the typical Ulysses soils in the county. This profile is north of a road in a native pasture (880 feet west of southeast corner of SW¼ sec. 9, T. 1 N., R. 22 E.):

A_1 0 to 9 inches, dark-brown (10YR 3/3, moist) silt loam; moderate, fine to medium, granular structure; friable; slightly calcareous.

B_2 9 to 28 inches, very dark grayish-brown (10YR 3/2, moist) light silty clay loam; medium, subangular blocky structure; barely visible clay skins on peds; friable; calcareous.

C_{ca} 28 to 40 inches, yellowish-brown (10YR 5/4) silt loam; massive (structureless); porous; friable; calcareous; concretions of calcium carbonate make up less than 1 percent of horizon.

ULYSSES SILT LOAM, 3 TO 5 PERCENT SLOPES (MODAL)

This soil is on convex slopes on moderately sloping uplands. It formed in fine-textured deposits of calcareous loess on the fringes of the High Plains. The profile described is in a road cut in a cultivated field (200 feet north of southwest corner of SW¼ sec. 10, T. 1 N., R. 22 E.):

A_1 0 to 10 inches, brown (10YR 5/3, moist) silt loam; weak, fine, granular structure; friable; calcareous.

A_c 10 to 50 inches, yellowish-brown (10YR 5/6, moist) silty clay loam; moderate, coarse, prismatic structure that breaks to medium and strong, medium and fine, granular; strongly calcareous; soft concretions of lime make up 2 percent of horizon.

C_{ca} 50 to 65 inches, strong-brown (7.5YR 5/6) silty clay loam; porous; soft concretions of lime make up less than 1 percent of horizon.

VERNON LOAMS (MODAL)

These soils are on rolling, dissected, erosive uplands. They formed in Permian red beds of shale overlying sandstone, along the breaks of valleys. The profile described is on a prairie in native pasture (330 feet west and 100 feet south of northeast corner of NW¼ sec. 30, T. 2 N., R. 20 E.):

A 0 to 6 inches, dark reddish-brown (5YR 3/4, moist) clay loam; calcareous.

C 6 to 16 inches, reddish-brown (5YR 5/4, moist) clay; calcareous.

D_r 16 to 65 inches, dark-red (2.5YR 3/6, moist) shale.

Suitability of Soil Associations for Conservation Structures

The soil associations, or general soil areas, in Beaver County are described generally in the section "General Soil Map." In the following pages the suitability of these soil associations for conservation structures is discussed.

1. Richfield-Mansic association

This soil association consists of rolling soils on long, smooth slopes. It occupies about 250,800 acres and makes up a large part of the southern half of the county. The long, strong slopes and well-defined drainageways account for a considerable amount of water erosion. Most of the area is grassland and is somewhat protected from sheet erosion, but many active gullies are eating into productive grassland.

Diversion terraces can be used to divert the water away from the active gullies, and to prevent water from higher areas from running across cultivated fields. Cultivated soils in this area should be terraced with channel-type terraces that have open ends or partly blocked ends.

Irrigation is not feasible in this soil association.

On many sites, ponds of the impounding type can be built to supply water for livestock. The drainage areas normally deliver a large amount of water in a short period of time. To prevent flooding, pipe spillways that have adequate storage above them should be installed. Sites suitable for reservoirs are scarce, but good wells for supplying livestock are fairly numerous.

2. Otero-Pratt association

This soil association is in a rolling sandy area in the northern part of the county and has a total area of about 192,640 acres. Because the soils are sandy, wind erosion is a severe hazard. Sheet erosion is well controlled in places where the natural vegetation has been properly managed, but it is a definite hazard in overgrazed or bare areas. Cattle paths that run up and down slopes become active gullies, and gullying is severe.

The best way to control erosion is to revegetate, and then to manage the established grass well. If suitable spills can be obtained, diversion and erosion-control dams can be used to stop gullying. Because sand shifts from place to place, terraces are not suited.

This area is not suitable for irrigation.

Because of seepage and silting, it is extremely hazardous to build ponds for watering livestock. Some ponds built in the area have been completely filled with silt in 1 year. Wells are the most satisfactory source of water for livestock in the area.

3. Mansic-Woodward-Carey association

This soil association is in a rolling area along the south side of the Beaver River. It extends from the western boundary across about two-thirds of the county. Its total area is about 138,880 acres. Water erosion is considerable because of the slopes and the well-defined drains. Parts of the area that do not have sufficient cover are eroded by the wind.

Diversion terraces can be used to divert water away from small gullies that cut back into cropland, and to prevent water from higher areas from running across productive land. These terraces should be of the level, channel type with open ends.

Terraces can be used to control erosion on practically all the cultivated fields in this area. Channel-type or ridge-type terraces having partly closed ends can be used on the flatter slopes, and channel-type terraces having partly closed ends can be used on slopes of more than 3 percent. Vegetated waterways may be needed to control the discharge water from the diversion terraces and other terraces. In some places waterways may be needed to control the flow of water and the erosion in natural drains running through the area.

Only small plots of land in this area are suitable for irrigation because slope is generally excessive and sufficient water is not available.

The drainageways in the area provide excellent sites for dams of the impounding type that provide water for livestock. In some places where there is caliche, some seepage occurs. Most ponds contain considerable clay particles in suspension, but the water can be cleared by adding ground gypsum to the water in the pond or by scattering gypsum rocks along the drainageway above the pond. The ponds are susceptible to silting and should not be built below drainage areas that are not protected by conservation practices. If ponds are built in large drainage areas, pipe spillways should be installed and adequate storage for water should be provided above the pipe to prevent flooding. Wells generally are not satisfactory sources of water for livestock.

4. Ulysses-Richfield association

This soil association consists of gently sloping to moderately sloping soils between the flats and the steeper breaks of the Beaver River. It is in the southwestern part of the county and is mostly cultivated. It covers an area of about 130,560 acres. Because of the sloping land and the well-defined drainageways, considerable water erosion takes place. There is some wind erosion where cover is not sufficient for protection.

Diversion terraces are needed in many places to move water from small drains that are cutting uphill into productive soil, and to divert water from higher areas away from productive land. Level diversion terraces with open ends should be used on cultivated land, but the diversion terraces on grassland may require some grade.

Most of the cultivated land in this area should be terraced. The impounding-type terraces are satisfactory on slopes of less than 3 percent if they are blocked in such a way that the channel can be drained when necessary, and at places where fills have not been made. In most places channel-type terraces with open ends are used on the slopes of 3 percent or more. Ridge-type terraces can be used on the heavier soils on flat slopes. Vegetated waterways may be needed to control the water discharged from the diversion terraces and other terraces. In some places waterways may be needed to control the flow of water and the erosion in natural drains.

The slope of these soils is too great for surface irrigation, and climatic conditions make profitable sprinkler irrigation uncertain.

In the drains in this area are many good sites for constructing ponds to supply water for livestock. Silt from unterraced land, however, is a hazard and fills up the pond in a short time. Reservoirs are satisfactory if the silt can be controlled. Some wells in the area are used to provide water for livestock.

5. *Dalhart-Pratt association*

This soil association consists of gently sloping or undulating sandy soils in the northwestern part of the county. The town of Forgan is in the eastern part of the association. The total area is about 95,480 acres. Because water infiltrates rapidly and the slopes are gentle, water erosion is not an engineering problem. Where cover is not sufficient, however, wind erosion is considerable in both cultivated areas and grassland.

Diversions and other terraces are not suited to this area, because generally they would be very crooked and hard to farm. They are hard to maintain because the channels blow full of sand and because rodents cause considerable damage.

A considerable part of this area, generally on Dalhart soils, has surface irrigation. It is used mainly for sorghum and other forage crops. Because water enters the soil rapidly, the runs are generally short. The irrigated soils have a moderately low available water-holding capacity and require frequent applications of water. Climatic conditions make sprinkler irrigation impractical.

Irrigation reservoirs can be used but should be built to prevent excessive seepage. A considerable amount of water is lost through seepage in irrigation ditches, but this loss can be prevented by installing underground irrigation pipe. In most places nonreinforced concrete or plastic pipe is used.

Dams of the impounding type are not satisfactory for supplying water for stock, and reservoirs normally are short lived because of the movement of sand and silt. On grassland the most satisfactory supply of water for livestock is from wells.

6. *Otero-Mansker association*

This soil association is in a rather sandy, rolling area in the southeastern part of the county. It covers an area of about 89,600 acres. Because the soils are sandy, wind erosion is a hazard if the natural vegetation has been removed or overgrazed. Sheet erosion from water is also a hazard where the natural vegetation has been destroyed or reduced. Severe gullying follows sheet erosion in most places. The best way to control erosion is to seed grass and control grazing. Diversions or erosion-control dams can be used to stop the gullies if a suitable spill area can be found.

Small plots of the Mansker soils are suited to forage crops. In areas likely to be damaged by water from higher areas, diversions and impounding-type terraces should be used. Both ends of the terraces can be partly blocked, or one end can be completely blocked. All farming operations should be done on the contour.

Soils in this association are generally not suited to irrigation.

Water for livestock is obtained from wells, but in a few places ponds are generally satisfactory if the silt is controlled.

7. *Richfield-Pullman association*

This soil association consists of a gently sloping or level area along the southern border of the county, in a strip about 6 miles wide. It extends westward from the center of the county to within 6 miles of Texas County and has a total area of about 76,800 acres. Most of this area is cultivated. The topography is similar to that of the Dalhart-Richfield association, but the soils are heavier and have slower infiltration and higher available water-holding capacity. Most of this association is cultivated.

The long slopes cause some sheet erosion, which can be controlled by constructing diversion terraces with open ends. Ridge- or channel-type terraces that have open ends may be used in the more sloping areas. The diversions and other terraces should be level on the cultivated soils and may require vegetated waterways to control the water discharged from them.

These soils are easily leveled for surface irrigation. They are suited to irrigation because they are high in fertility and in available water-holding capacity. The removal of excess water from the soils is a problem where drainage is into old, shallow lakebeds. Reservoirs for supplying irrigation water are very successful on these soils. Although irrigation ditches lose little water, they tend to crack when they dry out.

In grassland, water for livestock can be obtained by building reservoirs or by drilling wells. Diversion terraces may be needed to divert sufficient water into reservoirs.

8. *Dalhart-Richfield association*

This gently sloping soil association is in the northwestern part of the county. It is south of the Dalhart-Pratt association and extends to within 2 to 4 miles of the Beaver River. Its total area is about 76,540 acres. Long slopes account for a considerable amount of sheet erosion, which can be controlled by constructing either diversion terraces that have open ends or terraces of the impounding type. Vegetated waterways may be needed to control the water discharged from the diversion terraces. In areas of the heavy Richfield soils, ridge-type terraces may be used. The diversion terraces are generally level on cultivated land, and they may have closed ends on the Dalhart soils. On the Richfield soils, partly closed ends should be constructed so they can be cut to drain the channel at places where fills have not been made.

Areas in this association can be easily leveled for surface irrigation. Irrigation reservoirs are satisfactory on the Richfield soils, but some seepage occurs in the Dalhart soils. Irrigation ditches are satisfactory in this association, except that some cracking occurs on the Richfield soils when the banks are dry.

Ample water for livestock can be obtained in the pastures by digging reservoirs, but silting is a hazard, especially where water drains from Dalhart soils. Diversion terraces may have to be used to divert runoff water into the reservoir. In most of the area, wells are satisfactory in supplying water for livestock.

9. Tivoli-Pratt-Likes association

This soil association consists of sand dunes that extend along the northern bank of the Beaver River all the way across the county and make up a total area of about 44,800 acres. These dunes are little affected by water erosion, but wind erosion is severe where the vegetation is thin or short. Large areas of dunes are active in this area, and shifting of the soils can be controlled only by vegetation and proper management.

10. Las Animas-Lincoln-Spur-Canadian association

This association has a total area of about 51,420 acres. It is on flats along the creekbeds and the bottom lands adjacent to the Beaver and Cimarron Rivers. When these streams overflow, severe erosion or deposition may occur. Water from higher areas may be a problem on the Spur and Canadian soils in cultivated fields.

Diversion terraces may be used to divert water from higher areas from cultivated fields. It is not practical to dike overflow water in most places. By using old cables and logs, the banks of streams can be effectively and inexpensively controlled so that channels do not shift and productive land is not destroyed. Terraces are impractical in this area.

If diversions are used, a good grass spillway is generally available, and waterways are not needed.

Spur and Canadian soils are easily leveled for irrigation, and water is plentiful. Overflows, however, will occasionally cause the loss of crops. Water is easily obtained for livestock by driving sand points or by drilling shallow wells.

Geology

A knowledge of the geology of Beaver County is useful in understanding the occurrence and distribution of the soils in the county. The location of these geologic formations is shown in figure 36. Figure 37 is a cross section that shows the geologic formations, the principal soil series, and the surface features along a line in the central part of the county.

The soils in this county formed largely in materials deposited during the Permian, Tertiary, and Quaternary geologic periods.

Permian Period

The Permian red-bed formations are the oldest exposed formations in Beaver County. The sediments that formed these beds were deposited during the Permian period, which was about 200 million years ago. The beds are readily distinguished by the reddish color of the iron oxides, which were formed in the arid climate that prevailed during the Permian period.

At times during the Permian period, shallow seas covered what is now Beaver County. The land was sometimes above the water and sometimes below it. When the inland seas dried up, vast deposits of gypsum and salts were left. The strata of these deposits can be seen in the Cloud Chief formation. The crossbedding that occurs in the Whitehorse group indicates that desert conditions existed when the land was not covered by water.

The continental uplift, during which the Appalachian Mountains appeared, occurred at about the close of the Permian period. Beaver County was raised above the level of the sea and probably was never again submerged. Erosion cut away the exposed formations and carried away large amounts of the raw, red earth. Valleys, canyons, and gullies soon dissected the land, leaving it rough and broken. In Beaver County, drilled wells have revealed that the uneven red-bed formation is more than a thousand feet thick in places.

In this county most of the red beds are covered with a blanket of material that is a part of later formations. In places geologic erosion has removed this blanket of younger material, and the red beds are exposed (see fig. 37). The mantle has had some effect, however, on the development of the soils in those areas. The Permian red beds constitute about 11.6 percent of the surface formations in Beaver County.

The Cloud Chief formation is younger than the Whitehorse group and covers it in many exposures in the county. It is near the surface, mainly along the southern slopes of the Beaver River and along the erosional valleys of the feeder streams that flow from the south. It is conspicuously exposed along the valleys of practically all creeks that empty into the Beaver River from the south, and along the southern banks of the Beaver River. Most of the northern bank of the river consists of sandhills (see fig. 36).

Along some of the creeks in the southern part of the county are bluffs, 10 to 50 feet high, that consist of red clay beds, siltstone, and shale, stratified with layers of gypsum or other salts of the Cloud Chief formation. Creeks that contain conspicuous exposures of the Cloud Chief formation are Clear, Camp, Kiowa, Duck Pond, Home, Six Mile, Dougout, Willow, Jackson, and Fulton.

The Cloud Chief formation becomes thinner as it extends from west to east, and it merges with the Whitehorse group. North of the Cimarron River, the outcrops of red beds are mostly of the Whitehorse group, which in other parts of the county is covered by later formations in most places. In places along the north bank of the Cimarron River, streams have cut through the overlying formations and have exposed the red earth of the Whitehorse group. Bluffs of this formation are 100 feet high in places and consist mostly of a wall of sandstone or packed sand. The fairly soft sandstone is reddish, very fine, and weakly consolidated.

A mantle of soils has developed where the Permian red beds are at the surface in Beaver County. In the smooth areas are the Carey soils, which are deep, fertile, and productive. These soils are silty and have a reddish subsoil that is related to the parent material. The shallow, reddish Vernon soils developed on the raw erosional breaks of the valleys. These soils are mostly in grass. On the upper slopes of these valleys, the red beds are generally intermingled with a thin mantle of later deposits of the Tertiary period. The Woodward soils are on the red beds in these areas where Permian and Tertiary deposits are intermingled. Like the Vernon soils, the Woodward soils are reddish in color, but they are more fertile than those soils. Some of the rocks that were brought in with the outwash sediments of later deposits are scattered on the ridgetops in places.

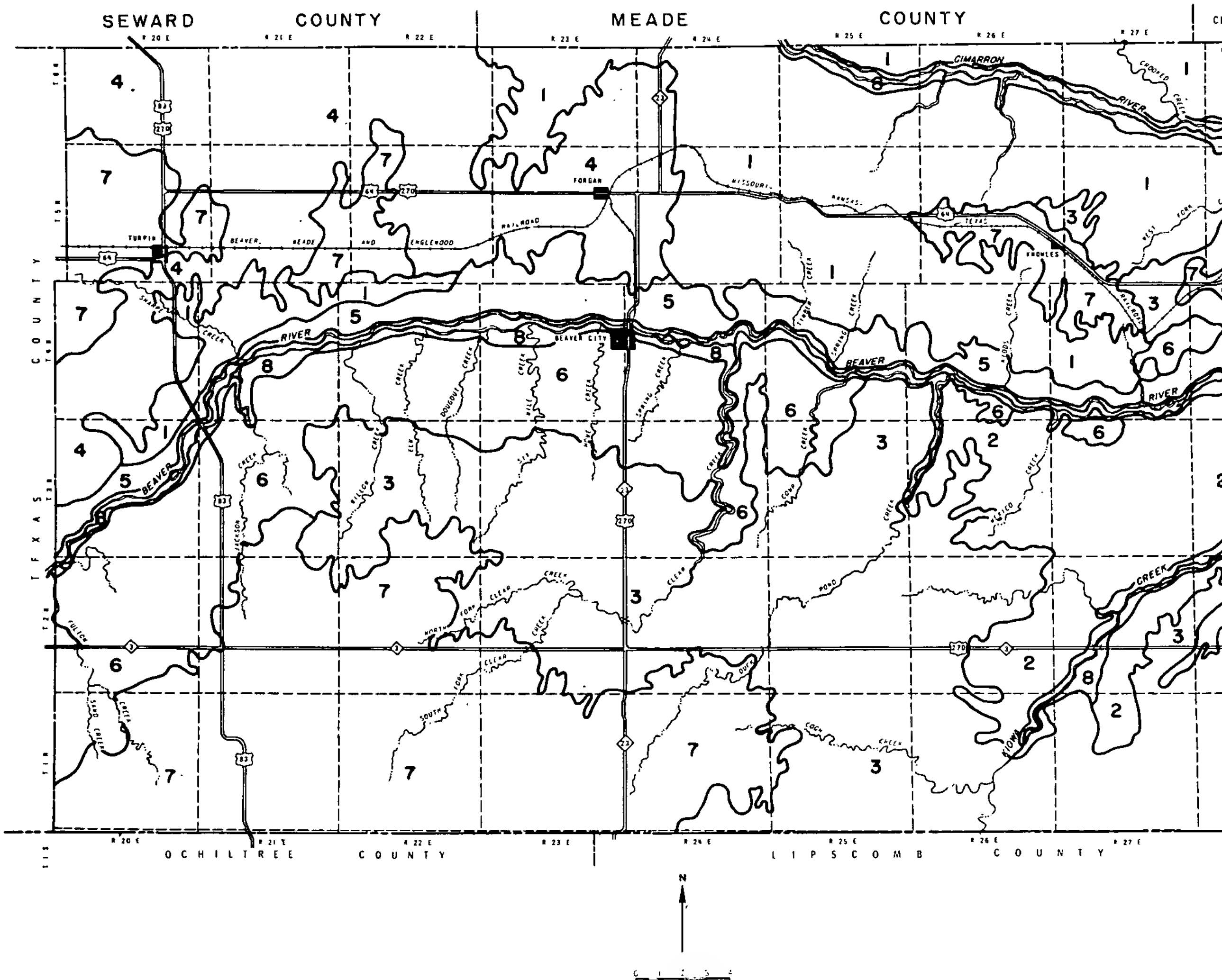

Figure 36.—Geologic map of Beaver County. (1) Tertiary High Plains outwash and Quaternary sand, (2) Tertiary Hig
wash, (3) Tertiary High Plains outwash and Quaternary loess, (4) Quaternary sand, (5) Quaternary sand dunes (rec
mian red beds and Tertiary High Plains outwash, (7) Quaternary loess, and (8) Alluvium.

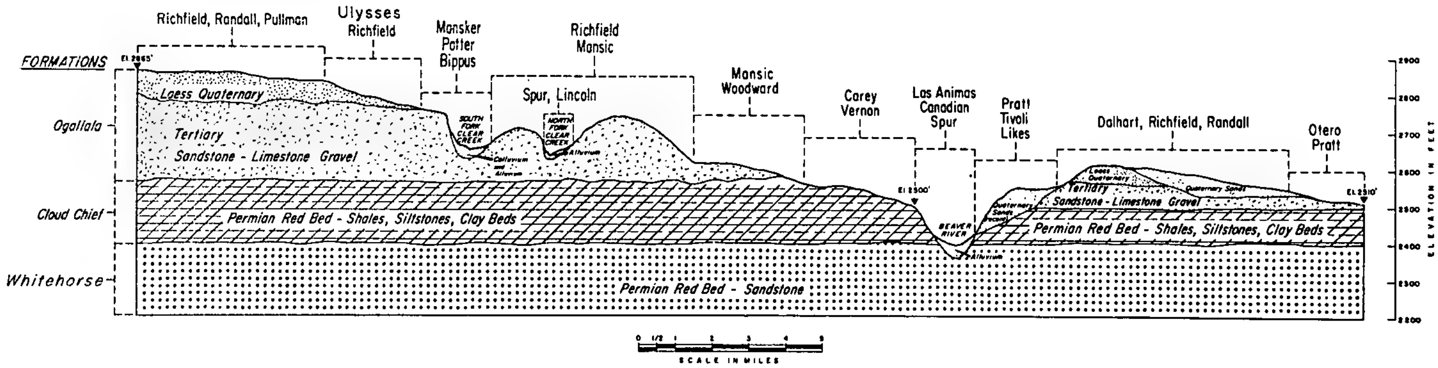

Figure 37.—**Cross section along a line in the central part of Beaver County.**

The Permian red beds were completely covered by the later deposits until geologic erosion removed the blanket. The soils that now occur on the red beds in Beaver County developed after this blanket was removed, and though the Permian red beds themselves are quite old, the soils that developed on them are much younger. Because erosion has failed to remove all of the later deposits in erosional areas, however, some soils that do not ordinarily develop on top of the beds have formed in the mantle that still remains.

In Beaver County, the Permian red beds are not a dependable source of ground water. In many places, however, water lies between the impervious beds and the formations that are above them, and in dissected areas water seeps out between the formations. For example, spring-fed creeks drain into the Beaver River from the south and cut the formations. Much of the water is not palatable, because it contains calcium sulfate and other salts from the gypsum in the red beds. Some of the salts are harmful to plants, and good water for irrigation is hard to find.

Much of the material in the Permian deposits in Beaver County is well suited to the construction of roads and to the manufacture of bricks.

Tertiary Period

More than 40 percent of Beaver County is covered by formations that were deposited late in the Tertiary period. This period began about 60 millions years ago and lasted until about 1 million years ago.

The formation of the Rocky Mountains and the erosion of the high parts of those mountains have affected the surface of Beaver County more than any other geologic process. The Rocky Mountains were formed in the latter part of the Tertiary period. When the mountains reached their highest elevations and erosion began, swift streams carried mixed gravelly materials great distances. The streams became less swift as the mountains were worn down, and the heaviest materials were deposited near the source of the streams. The finer textured materials were carried farther eastward by meandering streams. Swift desert streams spread over the area and dropped an assortment of silt, clay, and waterworn fragments.

In Beaver County the coarser fragments are covered in most places by finer textured materials. The finer materials were deposited by slowly moving waters that flowed at the end of the Tertiary period. Some of these coarse fragments occur in a groove that was probably a stream channel, and in places, erosion has uncovered these fragments. In some places they are used for construction material. The pebbles in the area are waterworn quartz, granite, or some other igneous rock. Some of the outwash material is exposed at the surface as weakly consolidated, lime-cemented conglomerates.

Waterworn pebbles are in some conglomerates. The shells and lime probably belong to the Cretaceous period, when shallow arms of the sea submerged part of the High Plains before the uplift of the Rocky Mountains. Though the sea never reached Beaver County, the materials from it were carried along with the Tertiary outwash material. The only seashells in place are in old fresh-water lakes. One such lake has been uncovered in the southeastern part of the county (sec. 32, T. 1 N., R. 26 E.). The shells in this lake are not waterworn and are excellent specimens.

The materials deposited in the outwash sediments in Beaver County consist mostly of a heterogeneous mixture of silt, clay, and gravel that is 200 to 300 feet thick in areas that have had the least geologic erosion. The deposits are not uniform; some consist of clay and lime and others of fine sand and clay or fine sand and coarse sand that, in some places, are loosely cemented with lime.

In many places crossbedding occurs, but in some places the layers are comparatively even. In places where erosion has been less active, layers of soft limestone are in the Tertiary deposits. These layers are discontinuous in some parts of the High Plains. They are exposed in breaks of the plains and are commonly called rimrock, caprock, or caliche. In places the limestone is in stratified layers, 10 to 15 feet thick.

Most of the caprock is in the southern part of the county. Where it is exposed, it is white and may be seen for several miles in bright sunlight. In areas below the caprock, most of the soft limestone has been removed through erosion; only small spots remain at the top of the higher soils. This stratified caliche was laid down by flowing water and should not be confused with leached lime that occurs in shallow layers under many soils in the county.

The Ogallala formation, which was laid down in the Tertiary period, is the main water-bearing stratum in the county and is the main source of water for irrigation. The Otero and Mansic soils have developed mostly where the outwash sediments are exposed, but the parent material

of the Otero soils has been reworked by wind in some places. Where more recent geologic erosion has not been great, much of the outwash material in this county has been covered by a mantle of wind-deposited material of Quaternary age.

Quaternary Period

Formations laid down during the Quaternary period underlie more than 35 percent of Beaver County. The Quaternary period began about 1 million years ago and included the Pleistocene epoch.

Pleistocene epoch.—During the Pleistocene epoch, much of the continent was covered by ice. The area that is now Beaver County was probably never reached by the principal mass of ice, but the loessal deposits in the county are probably a result of the action of this ice. As the ice sheet melted, ground-up deposits of debris and rock flour were left to form vast plains. Wind carried the floury material to Beaver County and to other places.

In this county the silty loessal deposits are most extensive where geologic erosion has been the least active. The main areas are in the southern part of the county above the caprock, in the northeastern part near Knowles and Gate on the level tableland, and in the northwestern part on the level plains. Wind probably leveled these areas. Below the level plains, in an erosional area, the loessal deposits are shallow and scattered and are less than 5 feet thick. To some extent, wind had reworked the loess and the underlying water-deposited sediments. The Ulysses, Richfield, and Pullman are the principal soils developed in loessal deposits in Beaver County.

Later in the Pleistocene epoch, moderately sandy material of local origin was deposited by wind, mainly in the northern part of the county. The Dalhart and Pratt are the most extensive soils developed in this material. Limy Otero soils formed in the northeastern part of the county where the Quaternary deposits are less continuous and the calcareous outwash material of the Tertiary period is exposed. The Otero and the Pratt soils are so intermingled in places that they are mapped in a complex.

The many small deposits of volcanic ash that are scattered over the eastern part of the county are also of the Pleistocene epoch. One of the largest of these deposits is in rough land north of Gate. This material is used in cleaning powders and is mined and shipped to different parts of the United States.

The ash came from active volcanoes in the Rocky Mountains in north-central New Mexico. During eruption of the volcanoes, gasses blew through the molten lava and made bubbles of liquid rock. As the bubbles burst, westerly winds carried the fragments and deposited them as a thick layer of dust over much of Nebraska, Kansas, Texas, and Oklahoma. Rainwater gradually carried this dust into streams, creeks, and depressions, where the ash settled out. As a result there are many scattered deposits. After the ash accumulated, more rain caused a layer of silt and clay to be deposited. In recent times drainageways have cut through many of these deposits and have exposed the ash.

The erosional forces that are forming the present hills, valleys, and streams began in the early part of the Pleistocene epoch or in the latter part of the Pliocene epoch and are continuing. In all probability, the greatest forces of water erosion in this region came at the time when the glaciers were being built up and when the ice sheets were melting in the Rocky Mountains.

A caprock marks the boundary between the relatively uneroded High Plains to the southwest and the more deeply eroded valleys of the Beaver River. The tableland near Knowles and Gate marks the divide between the erosional valleys of the Beaver River to the south and the Cimarron River to the north. The level plains and the undulating sandy area in the northwestern part of the county show little erosional terrain.

The Beaver and Cimarron Rivers were formed by the erosional force of water and, like all young streams, gradually cut their streambeds. Evidently the Cimarron River once flowed through an area immediately east of Forgan and intercepted the present channel of the Beaver River north of the town of Beaver. The Beaver River once ran through the valley east of Gate at the eastern edge of the county. These former streambeds are now a fertile valley.

The largest deposits of wind-deposited Quaternary sand are north of the Beaver River (see fig. 36). They are fairly young deposits and overlie the older formations in most places (see fig. 37). In the erosional valleys that adjoin the Beaver and Cimarron Rivers, geologic erosion has removed the blanket of Quaternary formation in places and has exposed the older Permian red beds.

The sandhills on the northern bank of the Beaver River are fairly recent deposits of the Quaternary period. They have been shaped in dunes by wind and generally range from 15 to 60 feet in height. The principal sandhills are in a strip 1 to 5 miles wide. These sandhills are composed of loose sand, which probably came from the streambed to the south. They contain little silt or clay and are mostly fine sand because most coarse fragments have sifted out. Each grain is wind blasted or pitted by bombardment. The Tivoli soils developed in these deposits.

Holocene epoch.—In Beaver County, the alluvial deposits of the Holocene (Recent) epoch consist of sand, gravel, and mud. Areas of these deposits are called bottom lands, valley wash, or flood plains. The character of the deposits depends largely on the area drained by the stream that deposited them. In a silty or clayey region, the alluvium is silty or clayey, and in a region where the deposits consist of coarser material, the alluvial deposits are mostly sand. The speed of the water and the distance the materials are carried also affect the kind of deposits. Generally, the finer particles of silt and clay are deposited by slow streams, and the heavier particles of sand and gravel are dropped by swift streams. Materials deposited by backwater on the flood plains consist of fine particles of silt and clay, and the soils formed in these are generally fertile.

Most of the alluvium in Beaver County occurs along the valleys of the Cimarron and Beaver Rivers, in strips 1 to 2 miles wide. Large amounts, however, are along the smaller streams in the county. The Spur, Canadian, Las Animas, and Lincoln are the main soils that developed in these alluvial deposits.

Alluvium also occupies the floor of playa lakes, or saucerlike depressions, that are common in the High Plains. Sometimes these depressions are called buffalo wallows because it was thought that they were formed

when great herds of buffalo wallowed in them. Wallowing buffaloes affected the formation of the large depressions, but the depressions have probably been caused mainly by the settling of sediments when salt and gypsum were washed away in solution. The basins or playas contain sediments washed from the surrounding uplands. They range in size from a few hundred feet across to slightly more than 600 acres, and the depth of the depressions is generally in proportion to the size. Smaller ones may be 2 or 3 feet deep, and the larger ones, as much as 8 feet.

Formation and Classification of Soils

This section is in two main parts. In the first part, the factors of soil formation are listed and the effects these factors have had on the formation of soils in Beaver County are discussed. In the second part, the soil series are placed in their soil orders and great soil groups and the morphology of the soil series in the county is described.

Factors of Soil Formation

Soil is formed by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of a soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and vegetation are the active factors of soil formation. They act on the parent material accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The kind of parent material also affects the kind of profile that is formed and, in extreme cases, dominates this profile almost entirely. Finally, time is needed to change the parent material into soil. It may be much or little, but generally a long time is required for development of distinct horizons.

The individual factors of soil formation are discussed separately in the paragraphs that follow. It is the interaction of all these factors, however, that determines the nature of a soil profile. The interrelationships among the five factors are complex; the effects of any one factor are hard to determine.

Parent material

Parent material affects the texture, structure, color, natural fertility, and many other properties of soil. Soils differ partly because their parent materials differ. The kind of weathering and time required for a soil to reach maturity also depend, in part, on the kind of parent material.

In Beaver County the material from which the soils developed consists of (1) deposits of loess of the Quaternary age, (2) outwash sediments of late Tertiary age, (3) red-bed material of the Permian age, (4) eolian sands of the Pleistocene epoch, and (5) alluvial deposits. The distribution of these materials in the county is shown in figure 36 in the section "Geology."

Loessal deposits.—The deposits of loess consist of relatively grit free, silty material that was deposited by wind. Thick deposits of this material occupy the smooth terrain above the broken caprock area in the southern part of Beaver County. These deposits are generally more than 10 feet thick and form a blanket on the outwash sediments. The Randall, Ulysses, Richfield, and Pullman soils are the main soils that developed above the caprock.

In the rolling, erosional terrain below the caprock, the mantle of silt is less continuous than it is above. Where it does occur, this mantle is generally less than 5 feet thick, and wind has mixed much of the material in it with the more sandy outwash deposits. The Mansic soils have developed where the outwash sediments are exposed, and the Richfield soils, where the silt mantle is present. The Richfield soils abruptly overlie older soils, which developed in the sediments before the silty material was deposited. In these areas of silt, the deposits of loess and the water-deposited materials have been reworked by wind and do not contain the high percentage of sand that is in the older soils that developed in the outwash sediments.

Other fairly uniform deposits of loess are in level areas around Floris and Turpin in the northwestern part of the county and on the tableland near Knowles and Gate in the northeastern part. The loessal deposits in the northwestern part of the county have been mixed by wind with some of the eolian sands, which contain feldspar and quartz. The sand grains are more uniform in size than in water-laid material, and their surfaces are pitted and wind blasted. The Richfield and Ulysses soils developed in these areas.

Soils that form in loess are fertile and high in mineral colloids. When the loess was first deposited, the soils did not contain much organic matter, but after native grass grew, organic matter was formed and greatly modified most soils. The activity of organisms also modified the soils.

Outwash sediments.—In the rolling, erosional uplands, mostly in the south-central and eastern parts of Beaver County, are areas of limy outwash sediments of the Tertiary age. These deposits occur as unconsolidated, stratified sand, silt, and clay or as weakly cemented, limy sand, silt, and clay. The deposits contain beds of caliche in places, and in broken caprock areas, these beds are exposed. Below the caprock, most of the water-laid caliche beds have eroded away, except those at the peaks of some of the slopes. The Potter and Mansker soils occur in these high-lime deposits.

Below these peaks, the Mansic, Mansker, and Otero soils formed in outwash sediments. Most areas of these soils have limy parent material and are high in lime. The lime deposits underlying the Mansic, Mansker, and Otero soils are calcium carbonate that has been carried downward by percolating water and deposited at the depths that the water reaches. In some places underlying the Potter soils, the caliche has been deposited in beds by water and is hard. Because of the hard deposits of lime, Potter soils are generally too shallow for good plant growth.

The fine particles of outwash deposits are high in minerals. The soils that developed in these deposits are mostly clay and silt and are fertile and well drained. The

coarse-textured deposits are high in quartz, and the soils that developed from them are less weathered and less fertile.

Permian material.—Permian red beds are exposed in areas where sediments have not been deposited or where deposited sediments have been removed. The Cloud Chief is the principal red-bed formation exposed in this county. It consists of soft, silty rocks; of clay beds; and of shale that is stratified in places with layers of gypsum. The Whitehorse red-bed formations, which are also exposed in the county, consist mostly of reddish sandstone. These formations weather somewhat more slowly than the loess or outwash deposits, and the soils are more red. The Carey, Woodward, and Vernon soils in Beaver County developed in materials deposited during the Permian age.

Eolian sands.—Much of the sandy material in Beaver County is wind laid and, therefore, contains no coarse fragments. The wind has pitted the sand particles and by bombardment has reduced the particle size. The sand consists mostly of feldspar and quartz, which are fairly resistant to weathering. In the older deposits weathering has occurred to a greater depth, and the soils are fairly fertile. The soils that formed in less weathered, coarse-textured deposits are less fertile than those formed in the sandy deposits that contain finer particles.

The first soils to develop in these wind-deposited sands were probably the Dalhart soils. Then the Pratt and Tivoli soils formed. On the northern slopes of the Beaver River, sand is still being added to the Tivoli soils on the sandhills, and the soils have had little time to mature.

Alluvial deposits.—The soils in this county that developed in alluvium are relatively young. Among these, the Spur and Canadian soils are on stable deposits and have a more developed profile than the Las Animas and Lincoln soils. The Las Animas soils and the Lincoln soils show little development.

Climate

Climate affects the formation of soils in many ways. Rain, snow, and ice, as well as variations in temperature that cause freezing and thawing, distintegrate the rocks or layers of debris on the surface of the earth. Climate also influences the formation of soils that develop from this disintegrated material. Temperature and moisture affect the kind and amount of vegetation that will grow and, therefore, indirectly influence the kind and amount of organic matter in the soil and the rate of decomposition of the organic matter. Temperature also affects the growth of organisms and the speed of chemical reaction in soil.

The freezing and thawing and variations in temperature affect soil structure. When moisture penetrates the soil, it leaches out minerals and nutrients and moves the fine particles of soil downward. After a long period of development, a soil reaches a state of equilibrium with its environment. The characteristics of the soil that exist at equilibrium are determined to a considerable degree by the climate prevailing during the time the soil was forming.

Though Beaver County has a continental climate, temperatures are extremely variable and change rapidly in summer and winter. This kind of temperature favors the formation of a good granular structure, which is an outstanding physical characteristic of most soils in the county. Winters are generally short and mild, and the average temperature ranges from 30° to 40° F. Summers are rather long and mild; the average growing season is 198 days. Elevations in the county range from about 2,200 to 3,000 feet above sea level.

The average annual precipitation is 19.36 inches. Because moisture is scarce in all seasons and evaporation is high, the plant nutrients in the soils are not depleted by leaching, and free calcium carbonates normally occur in the upper part of the C horizon. In many soils in this county, a zone of lime indicates the average depth to which water percolates. This zone may be near the surface in the sloping, clayey soils. Nearly level soils, however, may be leached to a depth of several feet, and many of the sandy soils in the county do not contain a lime zone. The downward movement of fine particles is greater in the nearly level soils than in sloping soils because the percolation of water is deeper.

Strong winds evaporate moisture rapidly and blow the fine particles of soil from the surface of unprotected areas. This loss of fine particles decreases fertility. On the other hand, thin layers of these particles have been blown to other areas that are under native vegetation.

Because the amount of rainfall is low, only a moderate amount of vegetation has grown on these soils. The soils, therefore, are not so dark and deep as are soils that formed in a more humid climate. Most of the soils in this county, however, contain ample organic matter for growth of plants.

Relief

Relief, or lay of the land, influences the formation of soils by affecting internal drainage, runoff, erosion, and vegetation. The influence of relief is modified by the other four factors of soil formation. In areas that are affected similarly by other factors of soil development, the degree of profile development depends mainly on the amount of moisture in the soil. Generally, the sloping soils absorb less moisture and produce less vegetation than nearly level soils. They are more eroded and have a less well developed, shallower profile. On strong slopes the soil-forming processes have been retarded by the continuing loss of material through erosion. On steep slopes runoff is great and little water percolates. Thus, on steep slopes, only a small amount of clay moves downward from the A horizon to form a B horizon, and lime and plant nutrients are not leached to a great depth.

Plant and animal life

Plants and animals contribute to soil formation. Plants gain a foothold when the parent material has disintegrated enough to furnish plant nutrients. Then, true soil begins to form. Organic matter is added to the soil when the first plants die and the bacteria in the soil increase. Some of the bacteria take nitrogen from the air and combine it with other elements to form nutrients that will be taken in by other plants. In the decaying process, acids are produced that help to decompose rock particles and to extract from them the plant nutrients that will aid plant growth. Organic matter from decayed plants influences the structure and other physical characteristics of the soil. Plants affect the climate on and in the soil by providing shade and by helping to retain moisture.

As the soil continues to develop, the activity of organisms increases. Micro-organisms, beetles, spiders, earth-

worms, rodents, and other animals are active and affect the formation of soil. In this region where trees are scarce, many rodents are forced to make their homes in the soil, and these add to soil formation by burrowing and by leaving body remains. Earthworms and small burrowing animals influence the soil by mixing organic and mineral parts of the soil and by deepening the zone where organic matter accumulates. Also, they tend to keep the surface soil supplied with minerals by bringing unleached parent material to the surface. Organisms thrive best where moisture is adequate and are most active in spring and fall. The nearly level and gently sloping soils absorb a large amount of water, maintain thick stands of grass, and, therefore, have a large amount of organic matter.

The native grasses in the county are mostly deep rooted and are, therefore, deep feeders. These plants bring up elements from the lower part of the soil and, when the plants die, add the elements to the upper part. The kinds of vegetation differ according to the kinds of soil. Generally, the hardlands of the virgin prairie supported short and mid grasses that have a full, matted sod. The more sandy soils supported tall grasses that are less dense but still add a large amount of organic material.

Permanent grasses have returned large amounts of organic matter and basic elements to the surface annually. Percolating water carried the bases downward through the soil. Enough calcium was returned to the surface layer to prevent the removal of bases and the dispersion of soil colloids. The high fertility of the soils in this county is largely the result of the effect that grass has had on the development of the soil.

Time

It takes a long time for a soil to mature. Particularly in the early part of soil formation, the weathering of rock and debris and the accumulation of organic matter are extremely slow. As plants and organisms increase, soil forms faster. It is mature when the soil particles become finer, the profile deeper, and all except the least soluble original minerals are leached.

The oldest soils in the county are buried soils that lie under and form a composite with the Richfield soils in the eastern half of the county. These old soils formed in outwash sediments and have a reddish color that indicates development in a climate different from that now prevailing in the county. They have a blocky B_2 horizon and are leached free of lime. These soils are on moderate slopes and have much stronger development than other soils in the county on moderate slopes. Pullman soils are also old and have a strong B_2 horizon. These soils formed on nearly level slopes.

The Ulysses soils, which occur with the Pullman soils and developed in the same kind of loess, are younger than Pullman soils because they are on stronger slopes. Their B_2 horizon is indistinct and in some places has not formed, because percolating water has not had enough time to leach minerals, nutrients, and fine particles downward. Free carbonates are commonly near the surface of the Ulysses soils, but in the Pullman soils they are normally leached to a depth of 3 feet or more. Thus, even though the parent materials of these soils are of comparable age, differences in climate and topography have affected their maturity.

The Tivoli soils, which occur in the region of the sandhills, are among the youngest soils in the county because they are steep and their parent material has been recently deposited. These loose, porous soils have only sparse vegetation, and their soil development is slow.

Ordinarily, sand and red-bed shale are more resistant to weathering than is silty loess. In this county the shallow Vernon soils, which formed in red-bed material, have probably had sufficient time to develop, but erosion has been so severe that soil material has been washed away almost as quickly as it formed.

Classification of Soils

The lower categories of classification, the soil series, types, and phases, are discussed briefly in the section "How a Soil Survey is Made." In the following paragraphs, the higher categories, the soil orders and great soil groups, are explained. The soils in Beaver County are classified in three soil orders—zonal, intrazonal, and azonal.

Zonal soils are well-drained, well-developed soils that have formed under fairly similar conditions of climate and vegetation. It is on these soils that climate and vegetation have had the most influence, and relief the least. As a result, the soils that developed from various kinds of parent material have many properties in common. In Beaver County the great soil groups in the zonal order are the Chestnut and Reddish Chestnut.

Intrazonal soils have more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal effects of climate and vegetation. These soils are generally in nearly level areas in the county where both internal and external drainage are restricted or where geologic erosion is very slow. Intrazonal soils in this county are members of the Calcisol and Grumusol great soil groups.

Azonal soils are young because their parent material is resistant to weathering, their slopes are steep and eroded, or they have had insufficient time to form definite genetic horizons. They have few or none of the properties of zonal soils and have little or no profile development. Some azonal soils, however, do have a moderately dark A_1 horizon that apparently has a moderately high content of organic matter. Azonal soils in the county belong to the Regosol, Alluvial soil, and Lithosol great soil groups.

Soils in each of these three orders may be derived from similar kinds of parent material. Within any one order, however, major differences among soils appear to be closely related to differences in the kinds of parent material. Most soil series have characteristics that are representative of one or another of the great soil groups, and are classified accordingly. A few soil series, however, have some characteristics of two great soil groups. Such soil series are placed in the great soil group they resemble most closely, but they are classified as intergrading to the other great soil group. For example, soil series of the Chestnut group in this county have some characteristics of soils in the Regosol group and, therefore, are classified as Chestnut soils intergrading to Regosols.

In table 8 the soil series are placed in soil orders and great soil groups, and for each series are listed the characteristic parent material, topography, and physiographic position (fig. 38), as well as drainage and native vegetation. Study of this table will help the reader understand the genetic relationship of the soils.

TABLE 8.—*Soil series classified by higher categories, and factors that have contributed to differences in soil morphology*

ZONAL

Great soil group and series	Parent material	Topography	Physiographic position	Drainage	Native vegetation
Chestnut soils:					
Bippus	Calcareous, clayey deposits of colluvium and alluvium.	Gently sloping	Concave valley floors.	Well drained	Short grasses.
Dalhart	Eolian sands	Level to gently undulating.	Sandy plains	Well drained	Short, mid, and tall grasses.
Pratt	Eolian sands	Undulating to duned.	Sandy plains and duned areas.	Excessively drained	Mid and tall grasses, sand sagebrush, and yucca.
Pullman	Loess	Nearly level	High plains	Moderately well drained.	Short grasses.
Richfield	Loess	Level to moderately sloping.	High plains and dissected uplands.	Well drained	Short grasses.
Chestnut soils intergrading to Regosols:					
Mansic	Calcareous outwash sediments.	Gently sloping to moderately sloping.	Erosional uplands	Well drained	Short and mid grasses and yucca.
Ulysses	Loess	Level to moderately sloping.	High plains	Well drained	Short and mid grasses.
Woodward	Weathered sandstone, siltstone, and shale.	Gently sloping to moderately sloping.	Erosional valleys	Well drained	Short and mid grasses.
Reddish Chestnut soils:					
Carey	Weathered, red-bed sandstone, siltstone, and shale.	Level to gently sloping.	Erosional valleys	Well drained	Short, mid, and tall grasses.

INTRAZONAL

Great soil group and series	Parent material	Topography	Physiographic position	Drainage	Native vegetation
Calcisols:					
Mansker	Calcareous outwash sediments.	Gently sloping to moderately sloping.	Erosional uplands	Well drained	Short and mid grasses and yucca.
Grumusols:					
Randall	Clayey alluvium	Slightly concave	Floors of playa lakes.	Poorly drained.	

AZONAL

Great soil group and series	Parent material	Topography	Physiographic position	Drainage	Native vegetation
Regosols:					
Likes	Eolian sands moved from higher slopes.	Gently sloping	Concave footslopes of sandy soils.	Excessively drained	Mid and tall grasses and sand sagebrush.
Otero	Calcareous outwash sediments.	Gently sloping to moderately sloping.	Rolling, dissected sandy plains.	Excessively drained	Short and mid grasses, sand sagebrush, and yucca.
Tivoli	Eolian sands	Steep, undulating dunes.	Sandhills	Excessively drained	Tall grasses and brush.
Alluvial soils:					
Canadian	Moderately sandy alluvium.	Nearly level	Low terraces of major streams.	Well drained	Mid and tall grasses and sand sagebrush.
Las Animas	Loamy alluvium	Nearly level	Flood plains	Poorly drained	Mid and tall grasses; few shrubs and trees.
Lincoln	Sandy alluvium	Level to gently undulating.	Flood plains	Excessively drained	Tall grasses and woody plants.
Spur	Loamy alluvium	Nearly level	Low benches of streams.	Well drained	Mid and tall grasses.
Lithosols:					
Potter	Caliche	Gently sloping to steep.	Slopes of draws and breaks of High Plains.	Excessively drained	Mid grasses and climax forbs.
Vernon	Red-bed siltstone, clay beds, and shale.	Nearly level to steep.	Erosional breaks of valleys.	Well drained to excessively drained.	Short and mid grasses.

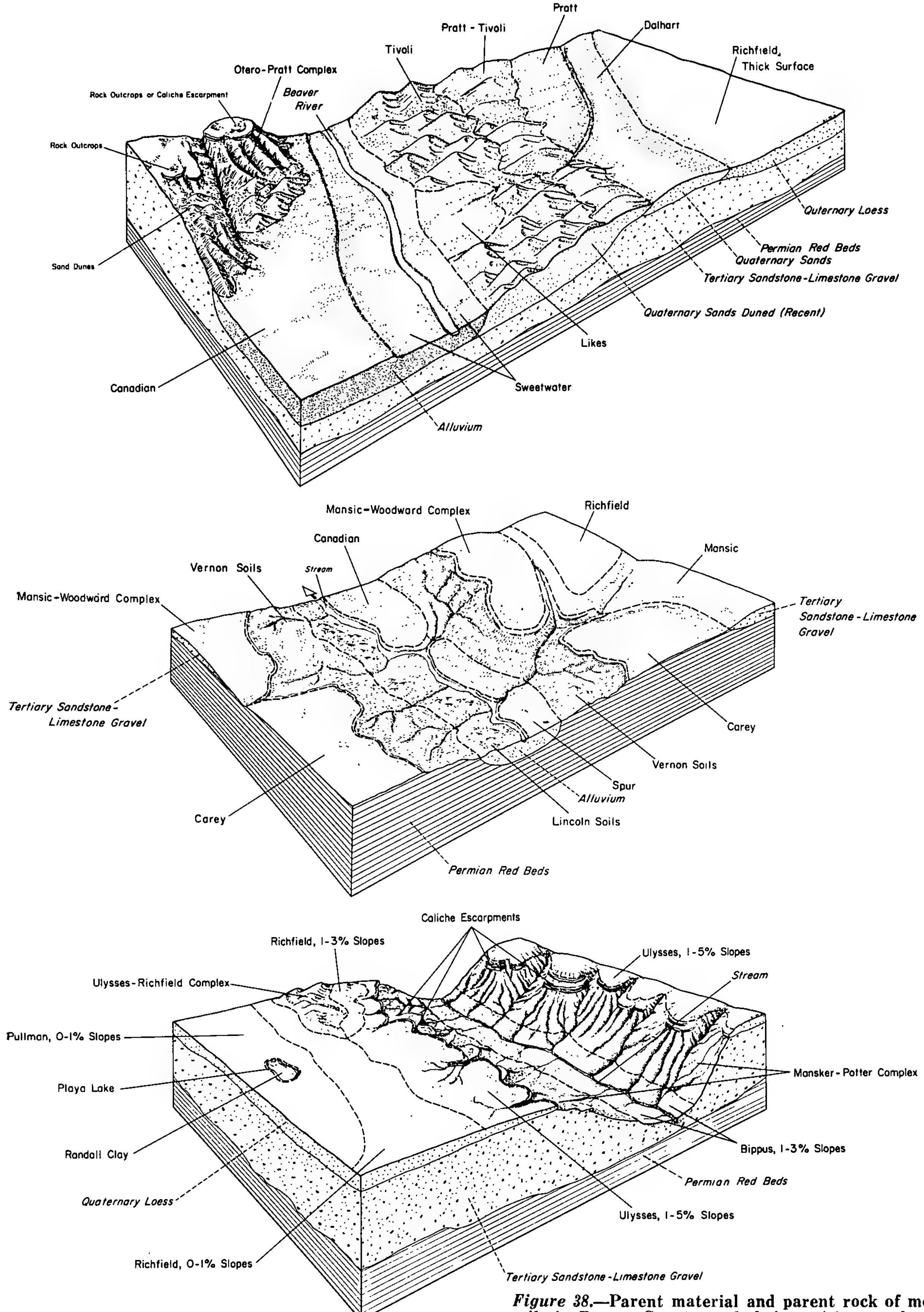

***Figure 38.*—Parent material and parent rock of most of the soils in Beaver County, and their position on the landscape.**

Beaver County lies in a marginal belt between two great soil zones. South of the county is an extensive zone of Reddish Chestnut soils, and to the north are Chestnut soils and Chernozems. Because they have less precipitation than Chernozems, Chestnut soils contain less organic matter and are shallower to carbonates.

The county is in a dividing belt of climate between two more distinct climatic areas, and climate is probably responsible for the variety of soils that formed in the county. The temperature of the county is cooler than that typical of regions where Reddish Chestnut soils generally form and is warmer than that typical of regions of Chestnut soils. Precipitation is higher than that in most areas of Chestnut soils and is lower than that in most areas of Reddish Chestnut soils.

Soils in the county that are less mature than the Chestnut and Reddish Chestnut soils belong to the Calcisol, Grumusol, Regosol, Alluvial soil, and Lithosol great soil groups. These seven groups are discussed in the following paragraphs.

Chestnut soils

These zonal soils have a dark-brown surface layer. The lower horizons are lighter in color than the surface layer and contain a layer of accumulated calcium at a depth of 1 to 4 feet. These soils formed under tall and short grasses in a temperate to cool, subhumid to semiarid climate.

The Pullman and Richfield soils, which formed in loess, are examples of the Chestnut soils in Beaver County. Their surface layer is dark brown to grayish brown and contains much organic matter. It is normally neutral in reaction. In places the A_1 horizon is as much as 22 inches thick. A granular structure is one of its outstanding physical characteristics. The B horizon receives material in solution or in colloidal suspension from the layer above. Some soils that are intergrades to other great soil groups do not have a well-developed B horizon. Leaching is incomplete in some soils with a B_1 horizon, and the horizon is calcareous.

Other Chestnut soils in the county are the Bippus, Dalhart, and Pratt soils. Intergrading from Chestnut soils to Regosols are the Mansic, Ulysses, and Woodward soils.

Reddish Chestnut soils

These soils developed on the grassy plains, which extend from southern Kansas southward through Oklahoma and Texas to the Gulf of Mexico. The climate is warm-temperate and semiarid or subhumid. The surface layer of these soils is typically dark reddish brown to red in the upper part. Below a depth of 2 feet, the soils are lighter in color and highly calcareous. They formed on uplands and bottom lands from various kinds of parent material. Though the vegetation is mostly grass, in places there are scattered brush and small trees. These soils are fairly high in natural fertility, but low rainfall and high evaporation limit the growth of crops. Calcification is dominant in their development.

Typical soils of this group in Beaver County are the Carey soils, which deevloped in siltstone, sandstone, and shale of the Permian red beds.

Calcisols

These intrazonal soils have a large accumulation of lime in the upper part of the C horizon. Like the Regosols, these soils do not have a textural B horizon. The Mansker soils are Calcisols in Beaver County.

Grumusols

Grumusols are sticky intrazonal soils that are almost impermeable to water. Randall clay is a member of this great soil group. Its sticky, clayey surface layer is underlain by a compact, stiff clay.

Regosols

These azonal soils lack a textural B horizon. In Beaver County, the Likes, Otero, and Tivoli soils are Grumusols. The Mansic, Ulysses, and Woodward soils in the county have a B horizon in some places and none in others. They are classified as intergrades from Chestnut soils to Regosols.

Alluvial soils

The Alluvial great soil group is an azonal group of soils that formed in transported and fairly recently deposited alluvial material. These soils have little or no profile development. In this county they are nearly level to gently sloping and are on first bottoms along streams, in depressions, and along drainageways that extend into the uplands. Internal drainage is medium to very slow. Alluvial soils are derived from similar kinds of parent material, but they vary in the texture of the surface layer. In Beaver County the Canadian, Las Animas, Lincoln, and Spur soils are Alluvial soils.

Lithosols

The Lithosol great soil group is an azonal group of soils that have no clearly expressed soil morphology. These soils consist of a freshly and imperfectly weathered mass of rock fragments, mostly on steep slopes where geologic erosion is fairly rapid. Thus, soil material is lost from the surface so quickly that the soils do not have enough time to form well-defined genetic horizons.

The Potter and Vernon soils are the Lithosols in Beaver County. The shallow Potter soils developed over hard, rocklike caliche and, in this county, occur only in a complex with the Mansker soils. These soils are mostly in the breaks of the valleys or in caprock areas. The shallow Vernon soils developed at the rims of the valleys in shale, siltstone, and clay beds weathered from the Permian red beds.

General Nature of the Area

This section has been written primarily for readers not familiar with Beaver County. It tells about the physiography, climate, history, crops, livestock, and other subjects of general interest.

Physiography

Beaver County consists of a part of the High Plains, breaks in the plains, and erosional uplands, valleys, and sand dunes. The surface was once a level plain that was built up by outwash material from the Rocky Mountains and was later dissected by the Beaver and Cimarron Rivers and their tributaries. The remaining parts of these plains are the broad, level High Plains in the northwest-

ern and southwestern parts of the county and the tableland near Knowles and Gate.

Below the High Plains are sloping, erosional uplands dissected by drainageways that lead into creeks and into the Beaver and Cimarron Rivers at the bottom of valleys. Breaks and ravines are between the erosional dissected uplands and the smoother High Plains. Many of these breaks contain layers of caliche and are called caprock areas.

Water erosion and the cutting action of streams have caused practically all the unevenness in the surface of Beaver County. Most of the cutting action occurred in periods of very high precipitation, which was at the same time that the area north of Beaver County was glaciated. In most places rivers have worn channels 200 feet below the level of the High Plains.

The sand dunes in the county are mostly on the northern slopes of the Beaver River. They occupy a strip, about 1 to 5 miles wide, that extends across the county and parallel to the river. The county drains generally eastward, the direction of the flow of the Beaver and Cimarron Rivers and their tributaries. Of the 54 townships in the county, about 43 are drained by the Beaver River and 11 by the Cimarron River. The Beaver River enters the county about 12 miles north of the southwestern boundary and flows northward for several miles before it cuts eastward across the county. The Cimarron River enters the north-central part and flows east, southeast, and then north. It leaves the county about 4 miles south of the northeastern corner.

From east to west, the county rises about 12.5 feet per mile. The elevation at Gate is 2,172 feet; at Knowles, 2,477 feet; at Forgan, 2,675 feet; at Beaver, 2,500 feet; and at Turpin, 2,770 feet.

Climate

Because of the climate, successful farming and ranching are difficult in Beaver County. Prolonged planning and the careful application of conservation practices are necessary to keep the soil from eroding and blowing.

The county has a dry, mild, continental climate, which is characterized by extremes and rapid changes in temperature and precipitation. For short periods the temperature in summer may be more than 100° F., but the heat is not oppressive and nights are generally cool because the humidity is low. Skies are almost invariably clear when the summer temperature is high, and dry, moderate winds blow from the south or west. Occasionally a hot southerly wind damages crops late in spring or in summer; winds are especially damaging when wheat is mature and ready to be harvested. In some dry seasons, especially on hardlands, hot winds parch the leaves of sorghum so that the plants cannot recover. Severe droughts generally follow long periods of hot wind and high temperature.

Winters are normally mild and short. Though the temperature occasionally drops below zero, extremely cold periods seldom last more than a few days. When winds are gentle in winter and the sun is bright, the days are pleasant, but in January, February, and March, many days are uncomfortable because of strong winds. In short periods when winds are high and the temperature is below zero, livestock, especially on the open plains, need special attention and more feed, particularly if there is snow. Blowing and drifting of snow is common in this region, and about once in a decade, a blizzard occurs that is similar to the one in March 1957. Then drifts covered automobiles, halted all transportation, and caused a tremendous loss of livestock and wildlife. Although the heaviest snows fall in February and December, at least a trace of snow has been recorded in Beaver County in all months except July. Many of these snows fall when there is little wind, and they add a large amount of moisture to the soil.

Table 9, compiled from records of the United States Weather Bureau Station at Beaver near the center of Beaver County, gives the monthly, seasonal, and annual temperature and precipitation. The annual temperature averages 57.4°. The highest temperature ever recorded is 115°, and the lowest is −20°. The frost-free period is approximately 198 days. April 5 is the average date of the last killing frost in spring, and October 20 is that of the first in fall. Killing frosts, however, have occurred as late as May 7 and as early as September 26.

About 72 percent of the average annual precipitation falls between April and September. As much of this moisture as possible must be saved to be used by wheat planted in fall. This wheat remains semidormant during the comparatively dry winter, and it matures after the

TABLE 9.—*Temperature and precipitation at Beaver, Beaver County, Oklahoma*

(Elevation, 2,560 feet)

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1933)	Wettest year (1941)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	35. 3	84	−16	0. 77	0. 40	0. 46	4. 0
January	33. 3	82	−20	. 46	. 03	. 87	3. 1
February	37. 0	90	−19	. 76	. 16	1. 57	4. 1
Winter	35. 2	90	−20	1. 99	. 59	2. 90	11. 2
March	46. 9	101	−12	. 97	. 15	1. 70	3. 5
April	56. 8	102	10	1. 91	. 62	2. 99	. 4
May	65. 8	107	22	2. 67	1. 26	5. 67	(3)
Spring	56. 5	107	−12	5. 55	2. 03	10. 36	3. 9
June	75. 7	112	37	2. 88	. 36	5. 07	(3)
July	81. 4	111	46	2. 09	. 75	4. 01	(3)
August	80. 3	115	41	2. 39	5. 07	3. 09	0
Summer	79. 1	115	37	7. 36	6. 18	12. 17	(3)
September	71. 9	110	29	2. 06	. 01	2. 64	(3)
October	59. 0	97	13	1. 50	. 54	6. 77	. 5
November	45. 3	94	−1	. 90	. 68	. 49	1. 4
Fall	58. 7	110	−1	4. 46	1. 23	9. 90	1. 9
Year	57. 4	115	−20	19. 36	10. 03	35. 33	17. 0

[1] Average temperature based on a 59-year record, through 1955; highest temperature on a 53-year record and lowest temperature on a 54-year record, through 1952.

[2] Average precipitation based on a 59-year record, through 1955; wettest and driest years based on a 48-year record, in the period 1899–1955; snowfall based on a 54-year record, through 1952.

[3] Trace.

rains in spring and early in summer. Rains late in spring and early in summer sometimes delay the harvest. If rainfall is equally distributed through the growing season, yields of wheat are good even when the annual precipitation is below normal.

The pattern of annual precipitation is somewhat irregular in Beaver County. The highest average of precipitation is in June, with May, August, and July following in that order. Some of the precipitation falls as light rain, and little if any of this reaches the subsoil. When heavy, dashing rains fall, much water is lost through runoff and causes severe erosion if the soils are not adequately protected. Ordinarily, winter rains are gentle, and the local showers in summer are spotty and erratic.

Destructive hailstorms occur almost every summer, but most of these are in small, local areas. Destructive tornadoes are not common in this area.

Most storms come as steady gales. The prevailing wind is southerly except in December, January, and February when northerly winds predominate. Strong winds frequently cause duststorms that are destructive to crops and soils. At least one severe duststorm can be expected in Beaver County between the early part of fall and the last of spring.

History and Settlement

Spanish adventurers and French fur traders visited the area that is now Beaver County before the United States acquired this area from France in 1803. Spain, however, was given title to the area in 1819, and it passed to Mexico in 1821 as a part of the Mexican State of Texas. It was a part of the Republic of Texas until Texas was admitted to the Union in 1845.

Texas gave a strip of the northern part of its territory to the United States because of the slavery provision in the Missouri Compromise. This strip included the area of Beaver County and was to become the Panhandle of the State of Oklahoma. The strip was called no man's land because it was not under the jurisdiction of a State or a territory.

After a railroad was built to Dodge City, Kans., thousands of cattle were brought into the strip, for it was covered with palatable grass. It abounded in buffalo and other game, including mountain lion, bear, prairie chicken, and a few wild turkey. The buffalo and other animals, however, were soon exterminated, and much of the grassland was damaged by overgrazing.

Though this strip was not open to settlement, homeseekers could enter as squatters, and many did. But the settlers had little success in farming, for available markets did not exist. Cattlemen also had difficulties. Blizzards in 1886 and 1887 killed thousands of cattle.

In 1886 a survey was made prior to opening the strip for settlement, and Beaver was founded. The first school in Beaver was constructed in 1886, and a church the following year. A railroad was extended to about 8 miles southwest of Liberal, Kans., in 1888. This spur was the first outlet for crops and livestock within a reasonable distance.

In 1890 Oklahoma became a territory, and Beaver was made the county seat of Beaver County, which then included all of the Oklahoma strip. Squatters' claims were registered after land surveys were completed. This ended big ranches, for small areas were fenced and new roads were built along section lines.

In 1907 Oklahoma became a State. Beaver County was divided into Beaver, Texas, and Cimarron Counties. A railroad was built to Forgan, 6 miles north of Beaver. Grain elevators were built in 1916, and modern buildings and homes began to replace those built of sod.

Many settlers came into the county. Some succeeded and others failed. Those who succeeded understand the importance of conservation and understand why this area was once called the Dust Bowl.

Natural Resources

The most important natural resource in Beaver County is soil, which is used to produce crops and grass for livestock.

Water, particularly ground water, is also important. Ground water can be easily obtained in the High Plains from moderately deep wells. Some of this water is used in homes, but most is used to supply livestock. Also, ponds are constructed on many farms to supply water for livestock. In the more nearly level areas of the High Plains, wells supply water for irrigation. Places suitable for these wells are hard to find because the wells have to supply a large amount of water quickly. In the High Plains the water is soft and of good quality. In the valley areas, however, Permian red beds have water that contains gypsum, sulfates, and chlorine and is not suited to domestic use. The ground water along the Beaver and Cimarron Rivers and other streams is of good quality in some places and contains salts in others.

Most of the streams that originate in the upland plains are spring fed and generally issue from beds of sand and gravel, mostly between the sand and the underlying Permian red beds. Such streams are Kiowa, Camp, Duck Pond, Clear, Willow, and Jackson Creeks in the southern part of the county. These streams carry water for a considerable part of the year, but their channels are filled with sand, and in dry periods the water sinks into the sand. The Beaver and Cimarron Rivers contain flowing water in wet periods but cease flowing in dry periods.

In the sandhills north of the Beaver River are springs that flow from the point of contact between the sand deposits and the underlying, fairly impervious clays and shales, mostly of the Permian red beds. Some of these springs feed Red Bluff and other small lakes. Red Bluff Spring, which is narrow and about 3 acres long, is next to the northern bank of the Beaver River, about 1 mile north and 6 miles west of Beaver. This lake is supplied by water that seeps out of a layer between the sand dunes and the underlying red beds.

The oil and gas industry has grown rapidly in Beaver County during the past decade. More than 750 wells have been brought into production since 1950, and the search for other wells continues. The oil and gas industry has increased the income of the county by providing royalties as well as work for many inhabitants.

One of the largest deposits of volcanic ash in Oklahoma is north of Gate. This volcanic ash is in a deposit of silicates, which is processed and used in such products as polishing powder, toothpaste, topping for roads, paint

filler, concrete, sweeping compound, insecticides, and insulating material.

A few deposits of gravel and sand are excavated for road surfacing and other construction work.

Transportation

Beaver County is served by the Missouri-Kansas-Texas Railroad and its subsidiary, the Beaver, Meade and Englewood Railroad. The subsidiary runs through Forgan, Floris, and Turpin in the county and connects with the Santa Fe line at Keyes in Cimarron County. A spur of this road serves the city of Beaver. The main line connects at Forgan; passes through Mocane, Knowles, and Gate; and crosses the eastern border of the county to pass through Laverne and Woodward in neighboring counties.

Except in the sandhills and in valley breaks, county roads are on practically all section lines in Beaver County. Good roads are easy to build because the soils have a mixture of sand and clay that makes good road grades, and the terrain of the county is suited to straight roadways. State Route 3 extends across the southern part of the county and passes through Slapout, Elmwood, and Bryans Corner. U.S. Highway No. 270 coincides with Route 3 as it extends westward, but it turns north at Elmwood, passes through Beaver, and joins U.S. Highway No. 64 about 6 miles north of Beaver. U.S. 64 crosses the county westward through Gate, Knowles, Forgan, and Turpin. U.S. Highway No. 83 runs north and south in the western part of the county and passes through Turpin, Boyd, Bryans Corner, and Gray. A paved road north and south through the center of the county is provided by the recent paving of State Route 23 from the Texas State line north to U.S. Highway No. 270 and from a point 2 miles east of Forgan to the Kansas State line.

Cultural and Recreational Facilities

The county school system provides elementary schools and high schools. Since 1914, 165 small school districts have been consolidated into 13 school districts, each of which has 1 large school. Of the 13 schools, 7 are rural elementary schools and 6 are combined elementary and high schools. Improvements in roads and transportation have made this centralization possible, and all schools in the county furnish bus service.

All the towns in the county and many rural communities have churches, which are of many denominations. Telephones serve all the towns and many of the farm homes. Most farms have electricity, and more than 75 percent have piped running water. Natural gas is the main domestic fuel on farms, and some farmers pipe this gas from their own wells.

Pheasant and quail hunting is a popular sport, and in hunting season, hunters from all parts of the State visit the county. Duck hunting is fair along the Beaver and Cimarron Rivers and around farm ponds and small lakes on the uplands.

Crops

Wheat and sorghum are the principal field crops grown in Beaver County. Sorghum is grown for feed or for a cash crop, and wheat is strictly a cash crop. The wheat is grown on more than 78 percent of the farms in the county and is well suited to many of the soils. Yields vary, however, and are highest on the nearly level hardlands on the uplands and on the deep, loamy bottom lands. In table 10 are shown acreages of the principal crops grown in the county for stated years. These figures were obtained from the United States Census of Agriculture.

TABLE 10.—*Acreage of principal crops in stated years*

Crop	1929	1939	1949	1954
	Acres	*Acres*	*Acres*	*Acres*
Sorghum for all purposes except sirup	77, 969	60, 116	52, 933	143, 592
Harvested for grain or seed	47, 431	29, 137	22, 722	61, 732
Hogged or grazed or cut for silage, hay, or fodder	30, 538	30, 979	30, 211	81, 860
Small grains threshed:				
Wheat	328, 803	196, 066	360, 384	219, 428
Oats	2, 645	1, 913	1, 700	1, 054
Barley	17, 487	10, 064	4, 250	5, 066
Broomcorn harvested	18, 824	1, 683	1, 909	2, 671
Corn for all purposes	12, 525	758	157	205
Hay crops, total	5, 286	4, 796	4, 836	6, 874
Alfalfa cut for hay	571	112	2, 598	3, 598
All seed harvested	324	141	1, 136	278

Between 1930 and 1954, the total land in wheat decreased by about 109,375 acres. Much of this acreage was replaced by sorghum, which increased by about 65,623 acres from 1930 to 1954. Some of this change in cropping was caused by the need for conservation measures. Also, some of the land that was cleared for cultivation was not suited to crops and has largely been returned to grass. But the main decrease in acreage of wheat was probably brought about through the Agricultural Stabilization and Conservation Agency, which sets planting allotments and manages the soil bank program.

In 1954 the most extensive hay crops were sorghum and alfalfa. Alfalfa, which is grown mostly on the Spur, Canadian, and Bippus soils on bottom lands, is irrigated.

Grade A dairies are increasing in number in the county and provide a market for silage. Large amounts of sorghum are cut for this purpose, not only as a cash crop and an immediate source of feed but also as reserve for droughty years.

Livestock

The raising of cattle, mostly for beef, is the second most important industry in the county. Herefords that are hardy and suitable for the range are preferred, but many Aberdeen Angus and a few shorthorns are also raised. Dairymen prefer Holsteins for large quantities of milk and Jerseys for their high production of butterfat. Table 11 shows the number of livestock in the county for stated years.

The number of milk cows has decreased in the county. Formerly, each farmer raised his own herd, but now the dairymen keep the large herds, and farmers keep only enough milk cows to supply products for home use.

A few registered cattle of all breeds are kept, and most of these are purebred bulls. Most of the beef cattle are for commercial use and each year are shipped to operators

TABLE 11.—*Number of livestock on farms in stated years*

Livestock	1930	1940	1950	1954
	Number	*Number*	*Number*	*Number*
Cattle and calves	54, 175	[1] 38, 715	58, 873	69, 517
Milk cows	7, 595	7, 717	5, 034	4, 481
Hogs and pigs	10, 870	[2] 3, 991	4, 430	4, 016
Chickens	[1] 181, 727	[2] 108, 939	[2] 79, 578	[2] 78, 215
Sheep and lambs	826	[3] 4, 659	404	1, 199
Horses and mules	11, 699	[1] 3, 702	1, 997	1, 149

[1] Over 3 months old.
[2] Over 4 months old.
[3] Over 6 months old.

of feedlots for fattening. The herds are mostly the cow-calf type, and a basic herd is kept the year round. Through annual culling and strict selection (fig. 39), the cattle are well known through the country for quality.

Between 1930 and 1954, the number of hogs and pigs in the county decreased 63 percent. Some hogs are butchered on farms, and others are marketed. To satisfy the demands of consumers, the lard-type hog has been replaced by the meaty type through crossbreeding. Popular crosses are Poland China or Duroc breeds with the Yorkshire breed.

Most flocks of chickens in the county are small and are raised mostly for home use. The number of chickens on farms has decreased steadily since 1930.

Few purebred sheep are raised in Beaver County. Most of the sheep are crosses of Hampshire, Southdown, or Dorset Horn with Rambouillet and Corriedale breeds and are commonly known as western sheep. These rugged crossbreeds yield mutton of good quality and do well on the range. The herds are ordinarily small throughout the year, but the number of sheep fluctuates greatly because, for short periods, some farmers graze large herds.

Horses and mules in the county have decreased in number because tractors have largely replaced animals in farmwork. Most of the horses are now used on cattle ranges for rounding up and managing cattle.

***Figure 39.*—Rounding up beef cattle for culling and selecting.**

Land Use in Beaver County

The approximate land area of Beaver County is 1,147,520 acres. About 538,804 acres, or 47 percent of the county, is in range. The native vegetation on the hardlands is short grasses; that on the sandy soils consists of mid and tall grasses. Sand sagebrush, yucca, and shrubs have invaded some areas.

About 556,008 acres in the county is in crops; 544,008 acres is dry-farmed, and 12,000 acres is irrigated. Woodland covers about 5,738 acres, and about 14,507 acres is idle or in farmsteads. The remaining 32,463 acres in the county is classed as miscellaneous land, which is land used by the public for other than agricultural purposes.

Of the 1,275 farms in the county in 1954, about 75 percent are classified as wheat farms.

Glossary

Aggregate, soil.—A mass or cluster of many soil particles held together in a granule, clod, block, prism, or other body.

Alluvium.—A soil material deposited on land by streams.

Aquifer.—A permeable, porous underground formation that will yield water.

Blowout.—An area from which soil material has been removed by wind. A blowout is usually barren and on sandy soils.

Border.—A small levee or ridge that divides an irrigated field into strips.

Calcareous soil.—Soil containing enough calcium carbonate to effervesce (fizz) when treated with dilute hydrochloric acid.

Caliche.—More or less cemented deposits of calcium carbonate that occur in many soils of warm-temperate areas. When it is very near the surface or is exposed by erosion, the material hardens.

Chisel.—A tillage machine with one or more soil-penetrating points that can be drawn through the soil to loosen or shatter the subsoil to a depth of 12 to 18 inches.

Clay.—As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. In engineering, fine-grained soil particles less than 0.005 millimeter in diameter.

Clay skin.—A dark-colored film of clay that coats the surfaces and pores of soil aggregates or peds. In many strongly developed soils, clay films occur predominantly in the B horizon and consists of clay leached from the horizons above.

Closed end (of terrace).—A ridge of soil across the channel at the end of a terrace that is designed to hold the channel two-thirds full of water.

Colluvium.—Mixed deposits of soil material and rock fragments near the base of steep slopes. The deposits have accumulated as the result of soil creep, slides, or local wash.

Complex, soil.—Two or more soils mapped as one unit because they are so intricately intermingled that it is impractical to show them separately at the scale of mapping used.

Concretion.—Local concentration of calcium carbonate, iron oxide, or other chemical compounds in the form of a hard grain or nodule of various size, shape, and color.

Consistence, soil.—The combination of properties of soil material that determine the resistance of the individual particles to separating from one another (cohesion) or the ability of a soil mass to undergo a change in shape without breaking (plasticity). Consistence depends mainly on the forces of attraction between soil particles. It varies with the moisture content. Thus, a soil aggregate or clod may be hard when dry and plastic when moist. Some of the common terms used to describe consistence are:

Firm.—When moist, crushes under moderate pressure, but resistance is distinctly noticeable. Firm soils are likely to be difficult to till.

Friable.—When moist, easily crushed by hand and coheres when pressed together. Friable soils are easily tilled.

Hard.—When dry, is moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.

Indurated.—Hard, very strongly cemented; brittle; does not soften under prolonged wetting.

Loose.—Noncoherent when moist or dry. Loose soils are generally coarse textured and are easily tilled.

Plastic.—When wet, retains an impressed shape and resists being deformed. Plastic soils are high in clay and are difficult to till.

Soft.—Weakly coherent and friable; when dry, breaks to powder or individual grains under slight pressure.

Sticky.—When wet, adheres to thumb and forefinger when pressed.

Contour furrow.—Furrows plowed at right angles to the direction of the slope, at the same level throughout, and at regular intervals.

Cretaceous.—A period of geologic time that occurred between 60 and 130 million years ago. Cretaceous material is geologic material deposited during the Cretaceous period.

Drop inlet.—An embankment built on or above an overfall and having pipes placed in the fill in such a way that the water is emptied on a base grade below the overfall. A large, vertical pipe with an open end at the top of the fill carries water to a horizontal pipe that runs through the fill and empties on the base grade.

Eolian deposit.—Windblown silts and fine sands.

Erosion-control dam.—An embankment constructed across a drain and, depending on the purpose of the structure, having a pipe spillway or a diversion spillway.

Gravel (engineering).—A coarse-grained soil of which more than 50 percent will not pass through a No. 4 sieve.

Head cut.—An overfall at the head of a gully.

High-bearing soil.—A soil that will hold its position and shape under heavy loads.

Impounding-type terrace.—A terrace built entirely from the downslope side.

Liquid limit.—The moisture content at which a soil changes from a plastic to a liquid state. The liquid limit of sandy soils is low, and that of clayey soils is high.

Loam.—The textural class name for soil having a moderate amount of sand, silt, and clay.

Loess.—Geologic deposit of fairly uniform fine material, mostly silt, transported by wind.

Low-strength soil.—A soil that breaks apart under heavy loads.

Mottles.—Spots or blotches differing from the rest of the soil mass in color.

Overhead water.—Excess surface water that drains onto or across lower lying areas from higher lying areas.

Parent material.—The unconsolidated material from which the soil develops.

Partial block.—A ridge of soil across the channel and at the end of a terrace that is designed to hold the channel one-half full of water.

Permian.—A period of geologic time that occurred between 185 and 210 million years ago; refers to geologic material deposited during the Permian period.

Physiography.—Description of the natural features of the land surface; physical geography.

Pipe drop.—A small embankment built above an overfall and having, through the embankment, a large pipe that allows water to drop to base grade from the end of the pipe.

Pipe spillway.—A hooded pipe inlet or a drop inlet used as a principal spillway through an earthen fill.

Plasticity.—Ability of a soil to change shape under pressure and to retain the impressed shape on removal of pressure.

Playa.—A flat-bottomed, undrained basin that contains water for varying lengths of time following rains. A playa may be dry for long periods.

Poorly graded soil (engineering).—A soil consisting of particles that have a narrow range of particle size, and thus, poor grain-size distribution. Such a soil can be increased in density only slightly by compaction.

Profile, soil.—A vertical section of the soil through all of its horizons and extending into the parent material.

Runoff.—Surface drainage of rain or melted snow.

Sand.—Individual rock or mineral fragments having diameters ranging from 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch). Sand grains consist chiefly of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. In engineering, coarse-grained soil, of which more than 50 percent will pass through a No. 4 sieve.

Silt.—Individual mineral particles that range in diameter from the upper size of clay, 0.002 millimeter, to the lower size of very fine sand, 0.05 millimeter. Soil of the textural class called silt contains 80 percent or more silt and less than 12 percent clay. In engineering, fine-grained soil particles that are larger than 0.005 millimeter.

Solum.—The part of the soil profile, above the unweathered parent material, in which the processes of soil information are active. In mature soils the solum is the A and B horizons.

Spillway.—A passage for draining excess water from behind a dam or other water-retarding structure.

Structure, soil.—The arrangement of individual soil particles into aggregates that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated soil particles. An example of a complete term of structure is moderate, medium, subangular blocky. This term expresses grade, class, and type.

Grade.—Degree of distinctness and durability of the aggregates. Grade expresses the differential between cohesion within aggregates and adhesion between aggregates. It is expressed as weak, moderate, or strong. Soil that has no visible structure is termed massive if coherent, or single grain if noncoherent.

Class.—Size of soil aggregates. Class is expressed as very fine or very thin; fine or thin; medium, coarse, or thick; and very coarse or very thick.

Type.—Shape and arrangement of the aggregates. Type is expressed as platy, prismatic, columnar, blocky, subangular blocky, granular, and crumb.

Texture, soil.—The relative proportions of sand, silt, and clay particles in the soil. (See sand, silt, clay.)

Coarse-textured soil.—Soil that contains a large proportion of sand and is loose and noncoherent when dry.

Moderately coarse textured soil.—Soil that has a high content of sand but has enough silt and clay to form fragile clods; individual sand grains easily seen, and soil mass feels gritty.

Medium-textured soil.—Soil that has about equal proportions of sand, silt, and clay; generally friable but forms stable clods.

Moderately fine textured soil.—Soil that contains a large amount of clay; generally hard when dry and firm when moist.

Topography.—The shape of the ground surface, including the position of its streams, lakes, hills, plains, and other land features.

Topsoil.—Presumably fertile soil used to topdress roadbanks, parks, gardens, and lawns.

Water-spreading systems.—A series of diversion terraces which spread overhead water across the slope by gated outlets or other means. Each terrace impounds a maximum of water with only the excess flowing to the terraces below it.

Well-graded soil (engineering).—A soil that consists of particles well distributed over a wide range in size. Such a soil normally can be easily increased in density and bearing properties by compaction.

Windbreak.—A narrow belt of trees or shrubs planted so that they will break or reduce the force of wind.

Winnow.—The removal of clay and silt particles from the soil by strong winds. The coarser textured particles are left, and the soil becomes sandier and highly erodible.

GUIDE TO MAPPING UNITS

Map symbol	*Soil name*	*Page*	*Capability unit*	*Page*	*Range site*	*Page*
Ac	Active dunes	6	VIIIe–1	32	None.	
Ar	Alluvial and broken land	7	VIe–3	31	Mixed Hardland and Shallow	46
BpB	Bippus clay loam, 1 to 3 percent slopes	8	IIIe–1	30	Hardland	46
CaA	Carey silt loam, 0 to 1 percent slopes	9	IIc–1	29	Loamy Prairie	46
CaB	Carey silt loam, 1 to 3 percent slopes	10	IIIe–1	30	Loamy Prairie	46
Cn	Canadian fine sandy loam	9	IIc–2	29	Sandy Bottom Land	44
DaA	Dalhart fine sandy loam, 0 to 1 percent slopes	10	IIIe–2	30	Sandy Plains	45
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes	11	IIIe–2	30	Sandy Plains	45
La	Las Animas soils	12	Vw–2	31	Subirrigated	44
Lf	Likes loamy fine sand	13	VIe–6	32	Deep Sand	44
Ln	Lincoln soils	13	VIe–1	31	Sandy Bottom Land	44
MaB	Mansker clay loam, 1 to 3 percent slopes	16	IIIe–1	30	Hardland	46
MaC	Mansker clay loam, 3 to 5 percent slopes	17	IVe–1	30	Hardland	46
McB	Mansic clay loam, 1 to 3 percent slopes	14	IIIe–1	30	Hardland	46
McC3	Mansic clay loam, 3 to 5 percent slopes, eroded	14	IVe–1	30	Hardland	46
McC4	Mansic soils, severely eroded	15	VIe–2	31	Shallow	46
MoB	Mansic-Otero complex, 1 to 3 percent slopes	15	IVe–2	31	Limy Sandy Plains	45
Mp	Mansker-Potter complex	17	VIe–3	31	Mixed Hardland and Shallow	46
MwB	Mansic-Woodward complex, 1 to 3 percent slopes	15	IIIe–1	30	Hardland	46
MwC3	Mansic-Woodward complex, 3 to 5 percent slopes, eroded.	16	IVe–1	30	Hardland	46
Om	Otero-Mansker complex	18	VIe–4	32	Limy Sandy Plains	45
OpD	Otero-Pratt fine sandy loams, 3 to 12 percent slopes	19	VIe–5	32	Sandy Plains	45
OtC3	Otero soils, 3 to 5 percent slopes, eroded	18	VIe–4	32	Limy Sandy Plains	45
PfB	Pratt fine sandy loam, undulating	20	IVe–2	31	Sandy Plains	45
Pm	Pullman clay loam	21	IIIc–1	30	Hardland	46
Pr	Pratt loamy fine sand	20	IVe–2	31	Deep Sand	44
Pt	Pratt-Tivoli loamy fine sands	20	VIe–6	32	Deep Sand	44
Ra	Randall clay	22	Vw–1	31	Hardland	46
RcA	Richfield clay loam, 0 to 1 percent slopes	23	IIIc–1	30	Hardland	46
RcB	Richfield clay loam, 1 to 3 percent slopes	23	IIIe–1	30	Hardland	46
RmC	Richfield-Mansic clay loams, 3 to 5 percent slopes	23	IVe–1	30	Hardland	46
Rt	Richfield loam, thick surface	23	IIIc–1	30	Hardland	46
Sp	Spur soils	24	IIc–2	29	Loamy Bottom Land	44
Tv	Tivoli fine sand	25	VIIe–1	32	Dune	45
Ur	Ulysses-Richfield complex	26	IIIc–1	30	Hardland	46
UsA	Ulysses silt loam, 0 to 1 percent slopes	26	IIIc–1	30	Loamy Prairie	46
UsB	Ulysses silt loam, 1 to 3 percent slopes	26	IIIe–1	30	Loamy Prairie	46
UsC	Ulysses silt loam, 3 to 5 percent slopes	26	IVe–1	30	Loamy Prairie	46
Ve	Vernon loams	27	VIIs–1	32	Shallow	46
Wm	Woodward-Mansic complex	28	VIe–3	31	Mixed Hardland and Shallow	46

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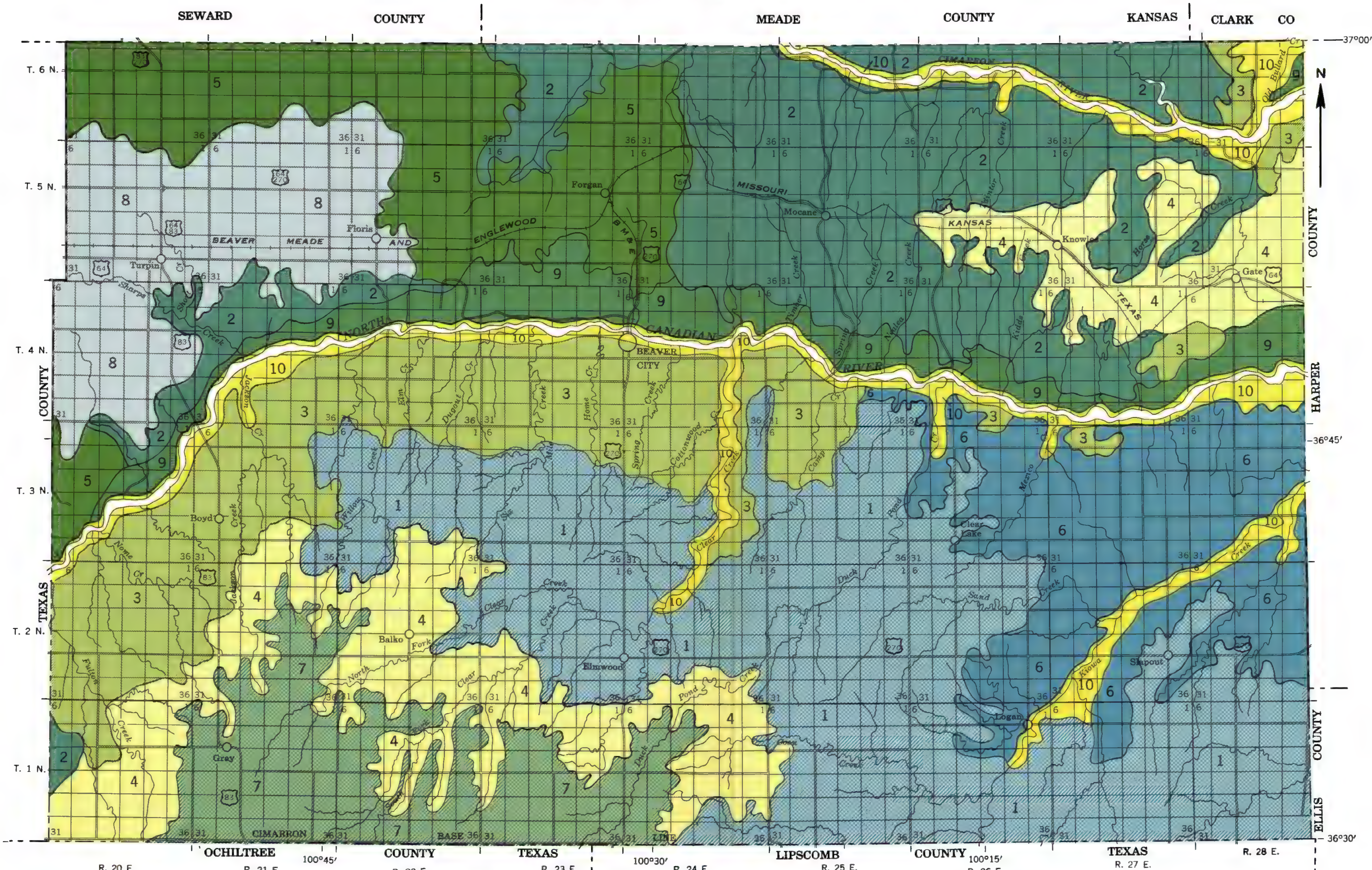
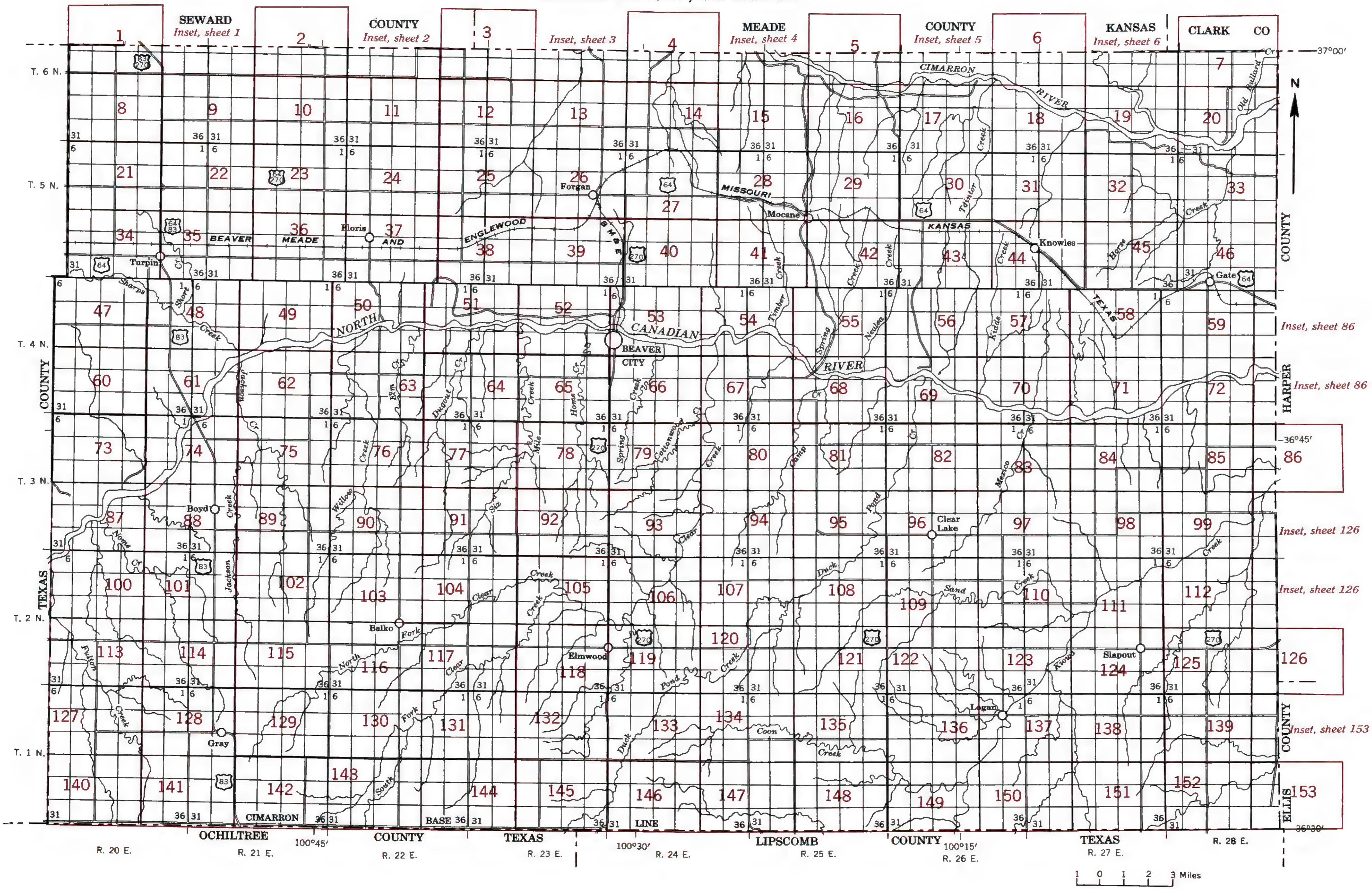
GENERAL SOIL MAP
BEAVER COUNTY, OKLAHOMA



SOIL ASSOCIATIONS

- 1 Deep, strongly sloping hardland: Richfield-Mansic association.
- 2 Deep and moderately deep sandy soils: Otero-Pratt association.
- 3 Deep, strongly sloping loamy soils: Mansic-Woodward-Carey association.
- 4 Deep, moderately sloping loamy soils: Ulysses-Richfield association.
- 5 Deep sandy soils and sand hills: Dalhart-Pratt association.
- 6 Gently sloping limy soils: Otero-Mansker association.
- 7 Deep, nearly level hardland: Richfield-Pullman association.
- 8 Deep, nearly level loamy soils: Dalhart-Richfield association.
- 9 Sand dunes: Tivoli-Pratt-Likes association.
- 10 Deep soils on bottom lands: Las Animas-Lincoln-Spur-Canadian association.

INDEX TO MAP SHEETS
BEAVER COUNTY, OKLAHOMA



SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, or D, shows the slope. Symbols without a slope letter are those of nearly level soils, such as Pullman clay loam, or of land types, such as the Mansker-Potter complex, that have a considerable range of slope. A final number, 2 or 3, shows that the soil is eroded.

SYMBOL	NAME
Ac	Active dunes
Ar	Alluvial and broken land
BpB	Bippus clay loam, 1 to 3 percent slopes
CaA	Carey silt loam, 0 to 1 percent slopes
CaB	Carey silt loam, 1 to 3 percent slopes
Cn	Canadian fine sandy loam
DaA	Dalhart fine sandy loam, 0 to 1 percent slopes
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes
La	Las Animas soils
Lf	Likes loamy fine sand
Ln	Lincoln soils
MaB	Mansker clay loam, 1 to 3 percent slopes
MaC	Mansker clay loam, 3 to 5 percent slopes
McB	Mansic clay loam, 1 to 3 percent slopes
McC3	Mansic clay loam, 3 to 5 percent slopes, eroded
McC4	Mansic soils, severely eroded
MoB	Mansic-Otero complex, 1 to 3 percent slopes
Mp	Mansker-Potter complex
MwB	Mansic-Woodward complex, 1 to 3 percent slopes
MwC3	Mansic-Woodward complex, 3 to 5 percent slopes, eroded
Om	Otero-Mansker complex
OpD	Otero-Pratt fine sandy loams, 3 to 12 percent slopes
OtC3	Otero soils, 3 to 5 percent slopes, eroded
PfB	Pratt fine sandy loam, undulating
Pm	Pullman clay loam
Pr	Pratt loamy fine sand
Pt	Pratt-Tivoli loamy fine sands
Ra	Randall clay
RcA	Richfield clay loam, 0 to 1 percent slopes
RcB	Richfield clay loam, 1 to 3 percent slopes
RmC	Richfield-Mansic clay loams, 3 to 5 percent slopes
Rt	Richfield loam, thick surface
Sp	Spur soils
Tv	Tivoli fine sand
Ur	Ulysses-Richfield complex
UsA	Ulysses silt loam, 0 to 1 percent slopes
UsB	Ulysses silt loam, 1 to 3 percent slopes
UsC	Ulysses silt loam, 3 to 5 percent slopes
Ve	Vernon loams
Wm	Woodward-Mansic complex

Soil map constructed 1961 by Cartographic Division, Soil Conservation Service, USDA, from 1953 aerial photographs. Controlled mosaic based on Oklahoma plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church

Station

Mines and Quarries

Mine dump

Pits, gravel or other

Power lines

Pipe lines

Cemeteries

Dams

Levees

Tanks

Oil wells

Windmills

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL, DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing

Springs

Marsh

Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

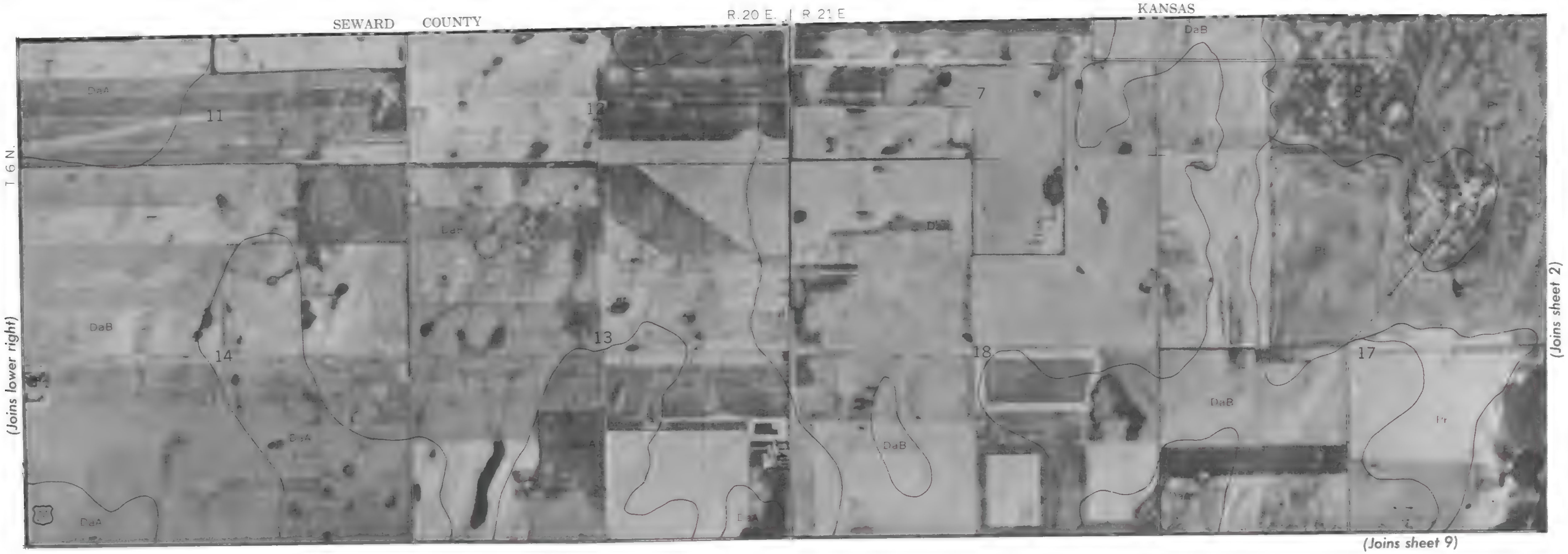
SOIL SURVEY DATA

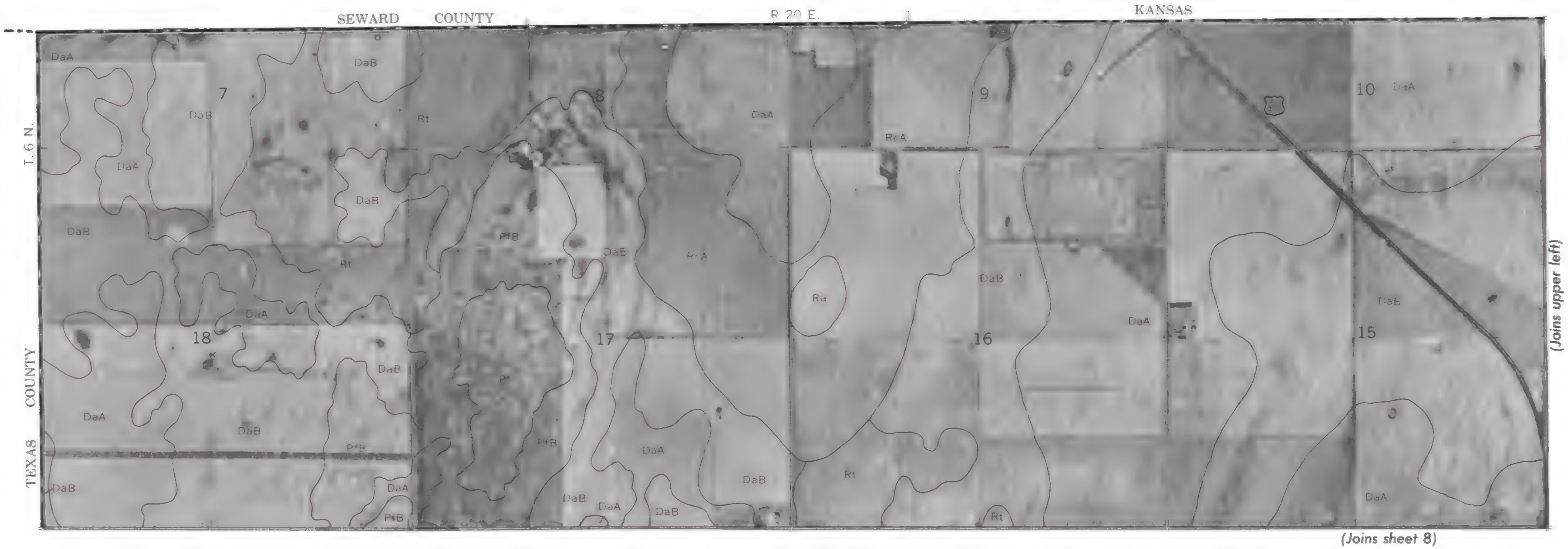
- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies

1

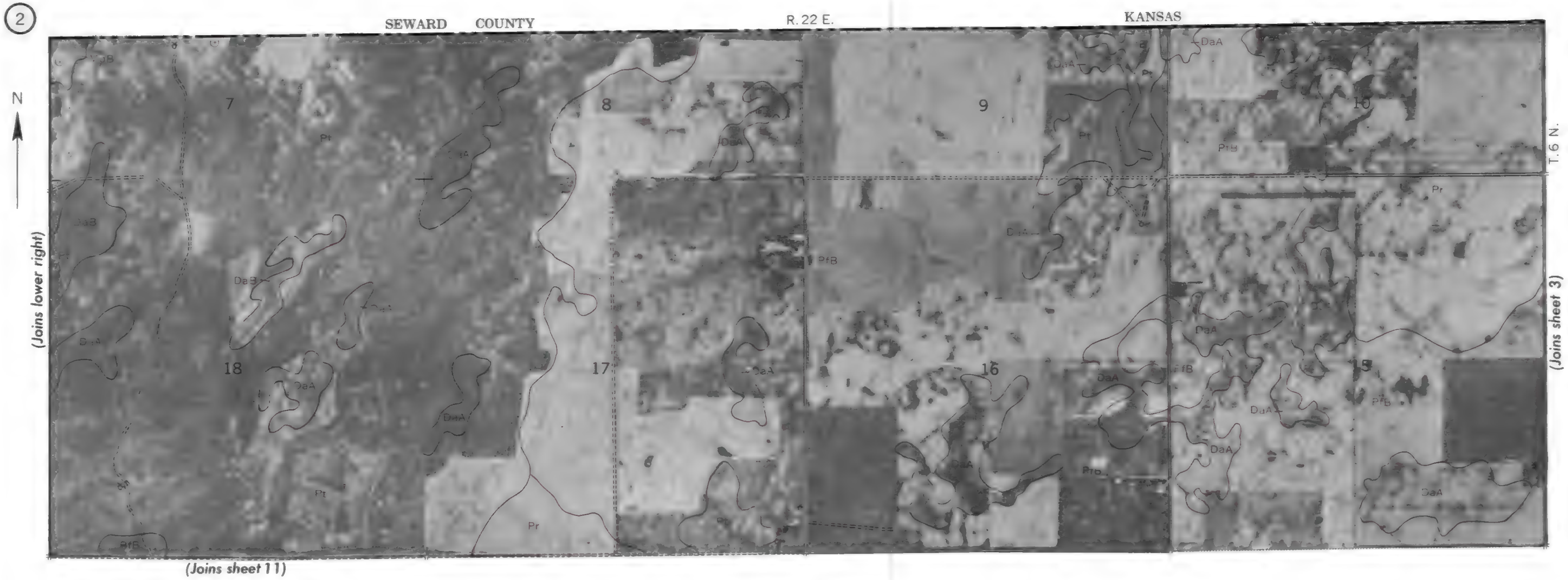
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

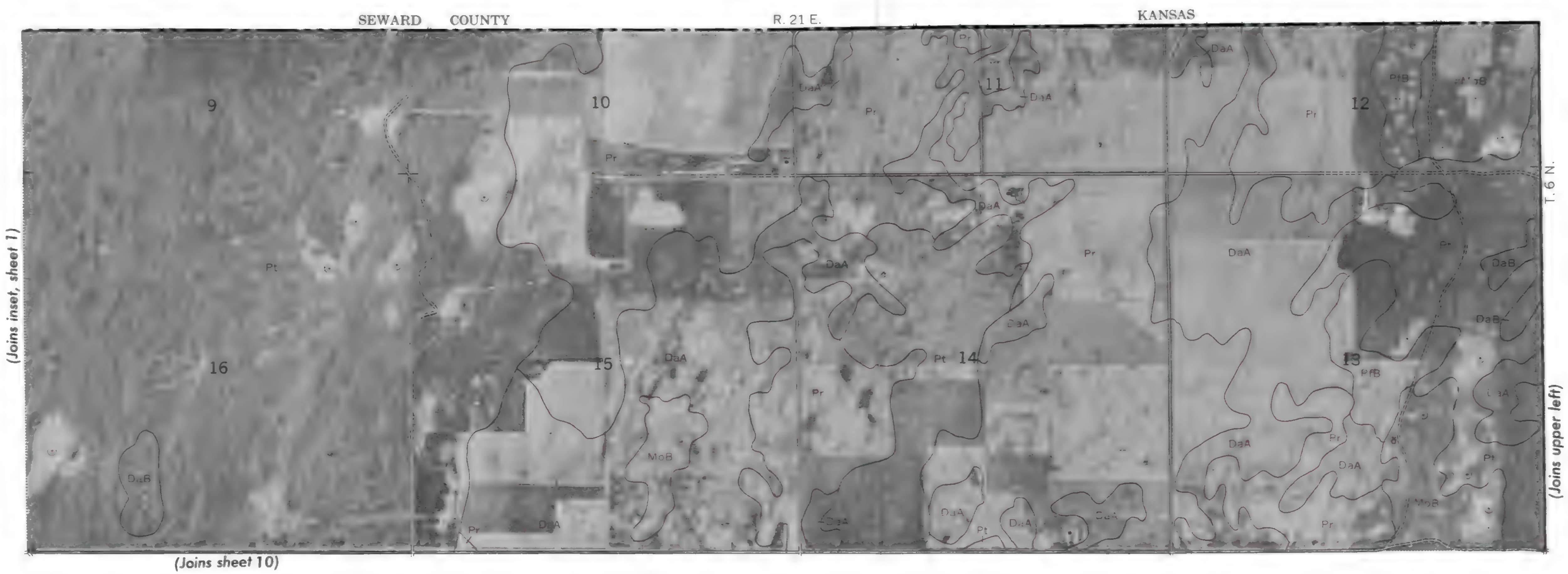
Range, township, and section corners shown on this map are indefinite.





0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



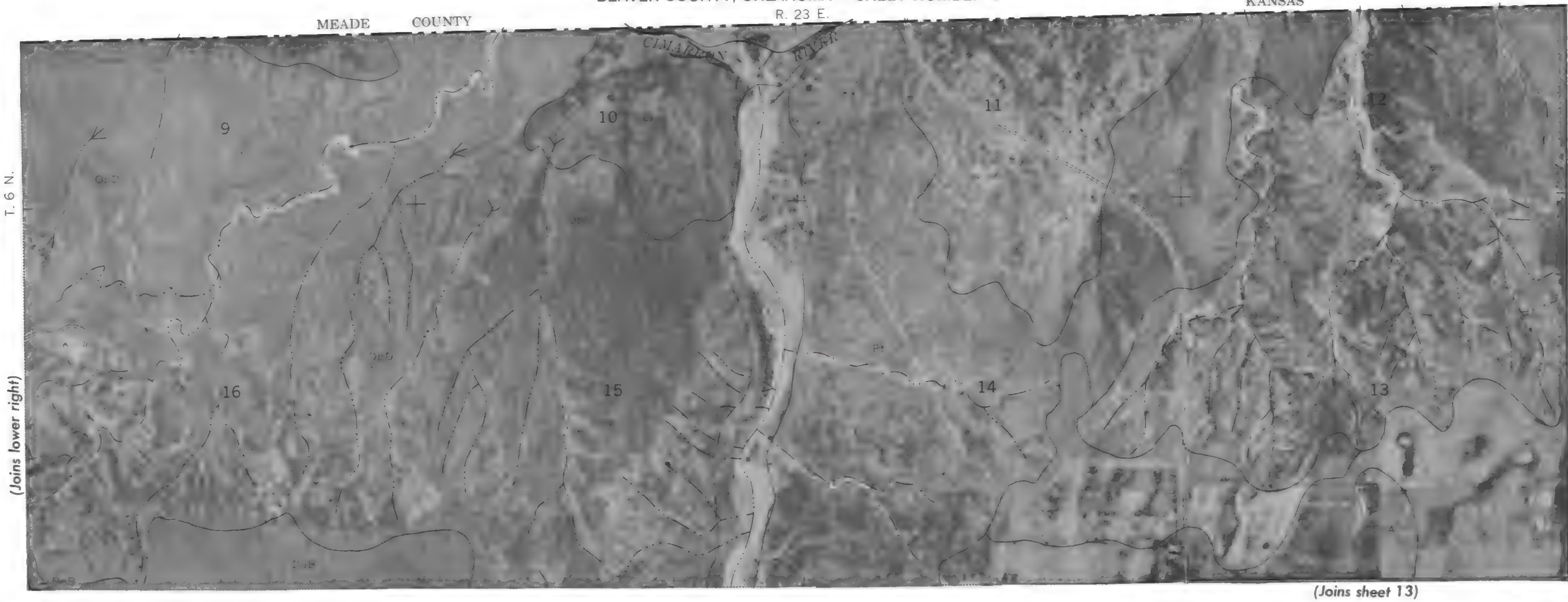


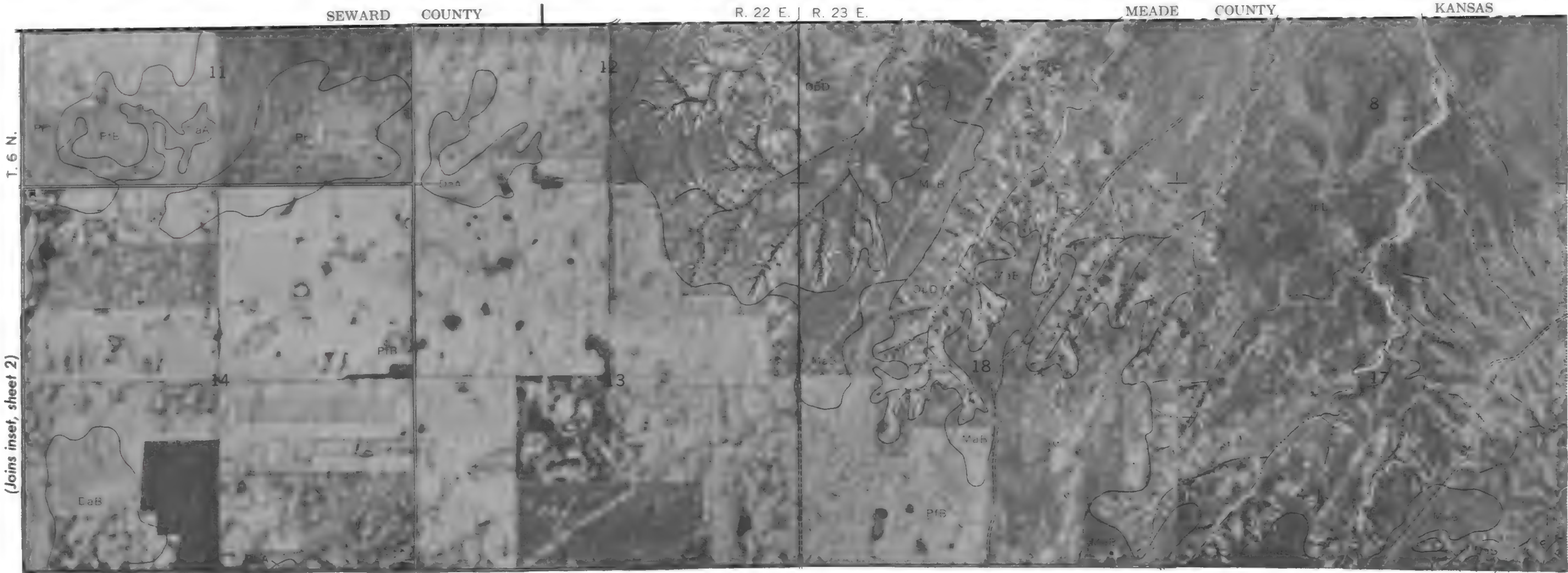
Scale 1: 20 000

0 ½ 1 Mile

0 5000 Feet

3





0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

N

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

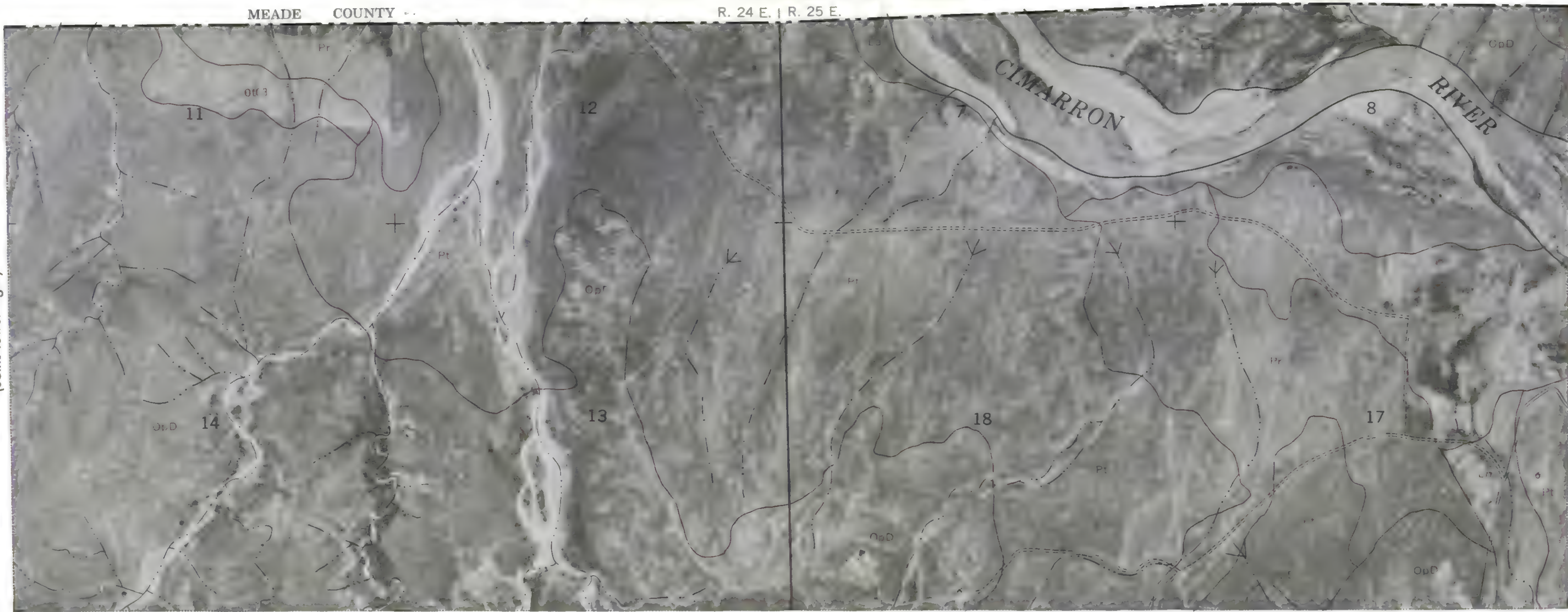
BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 4

4

MEADE COUNTY — R. 24 E. | R. 25 E. — KANSAS

N

(Joins lower right)



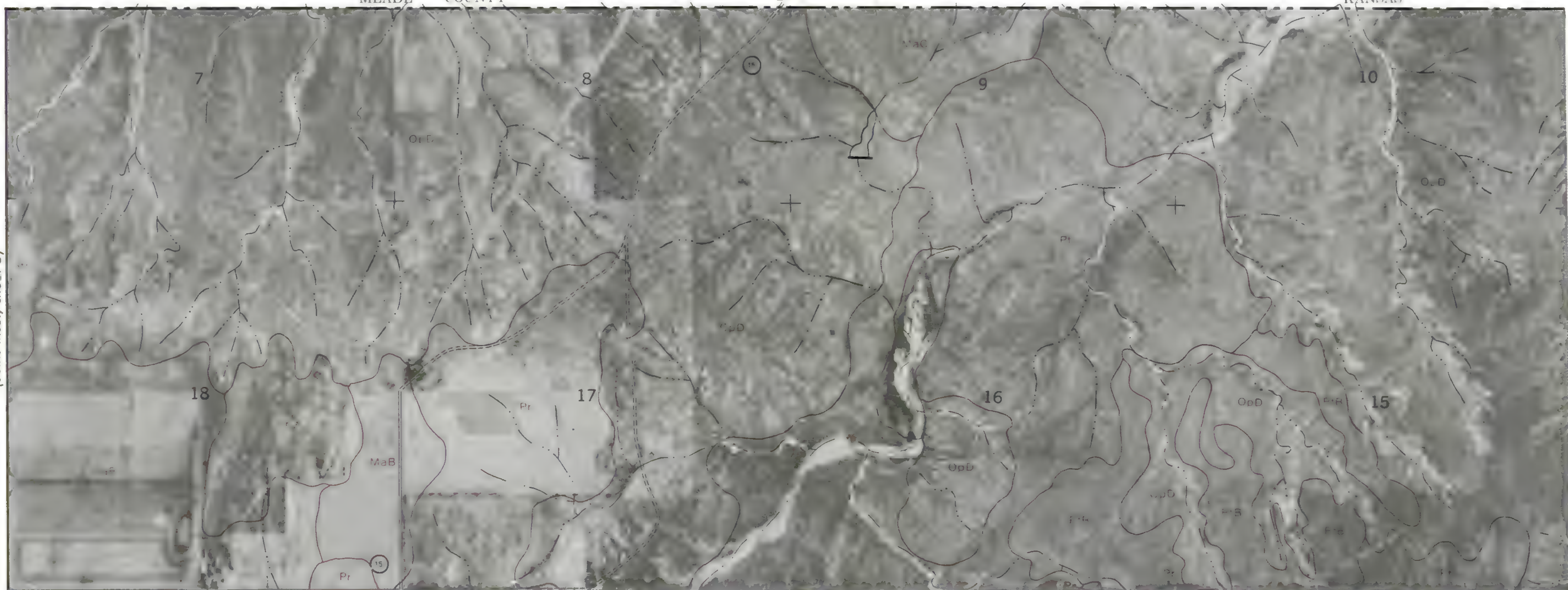
T. 6 N.

(Joins sheet 5)

(Joins sheet 15)

MEADE COUNTY — R. 24 E. — KANSAS

(Joins inset, sheet 3)



T. 6 N.

(Joins upper left)

(Joins sheet 14)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 5

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 19[illegible].

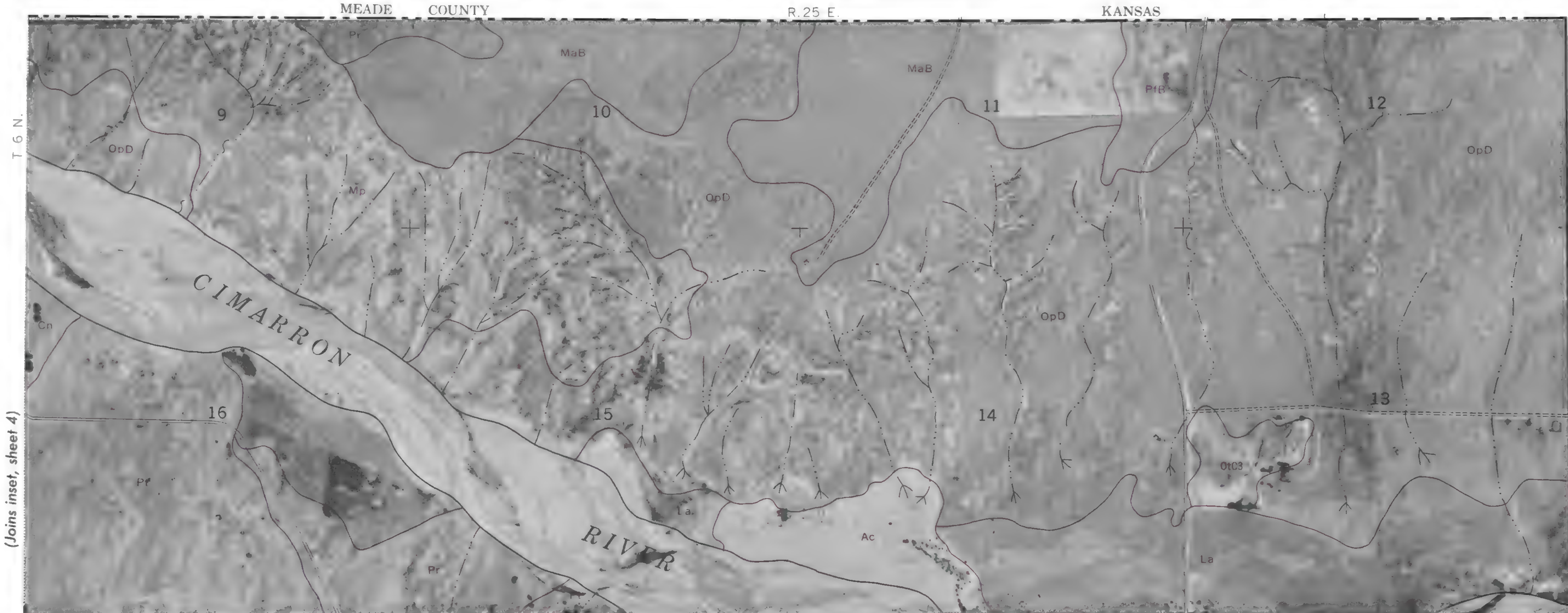
Range, township, and section corners shown on this map are indefinite.

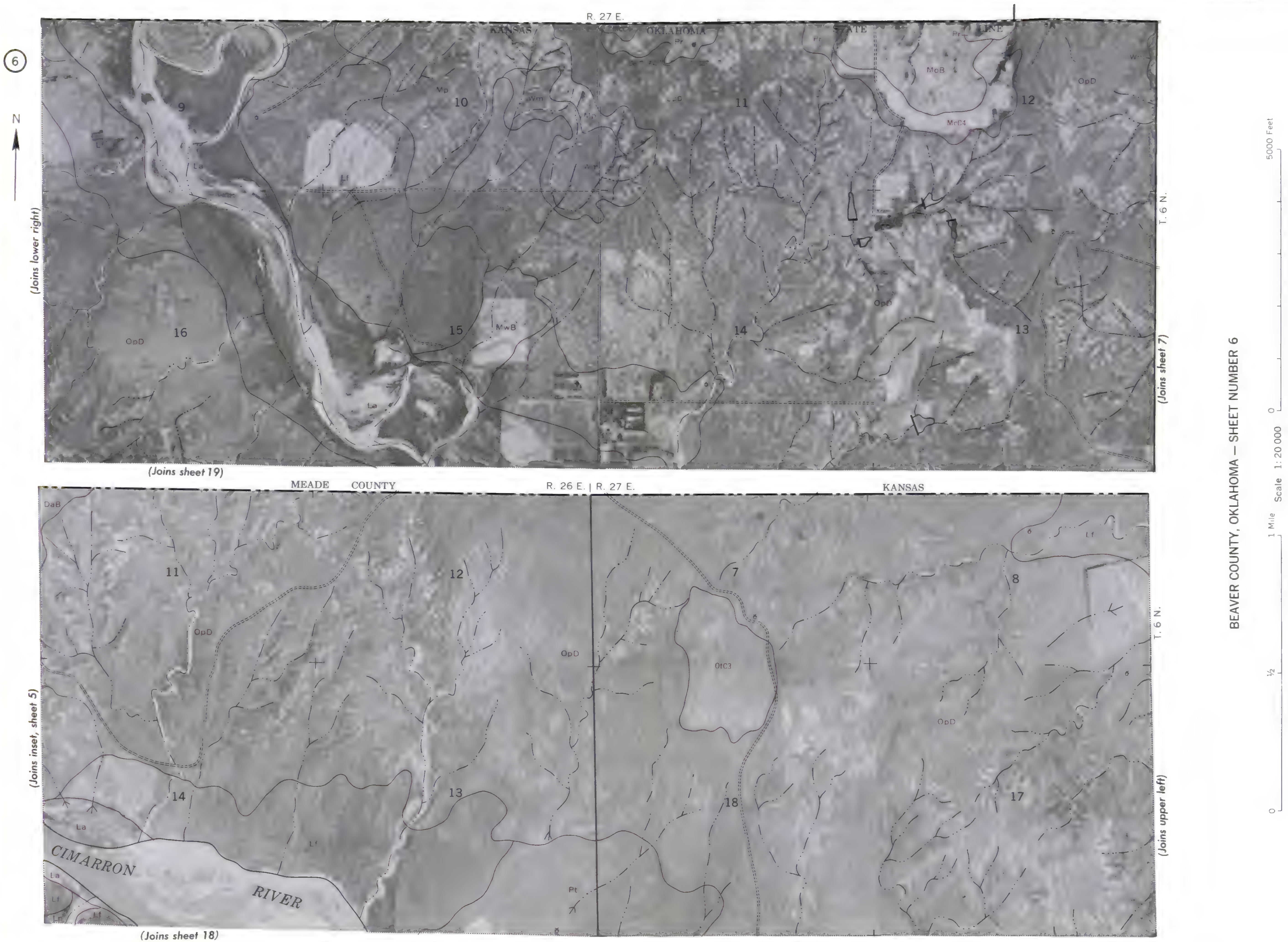
Scale 1:20 000

1 Mile — ½ — 0

5000 Feet — 0

5





BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 6

7

N

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

T. 6 N.

(Joins inset, sheet 6)

(Joins sheet 20)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


8
(Joins sheet 1)
R. 20 E.
N
T. 6 N.
TEXAS COUNTY
(Joins sheet 9)
(Joins sheet 21)
19
20
21
22
30
29
28
27
31
32
33
34
DaA
DaB
PtB
Pr
Pt
Rt
Ra
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 9

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

10

(Joins sheet 2)

R. 21 E.

N

(Joins sheet 9)

T. 6 N.

(Joins sheet 11)

(Joins sheet 23)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


100
(Joins sheet 87)
R. 20 E.
N
NORTH CANADIAN RIVER
TEXAS COUNTY
Fulton Creek
Nome Creek
Palestine Neighbor Center
T. 2 N.
(Joins sheet 101)
(Joins sheet 113)
6
5
4
3
7
8
9
10
18
17
16
15
Ac
Pr
OpD
MwB
Ln
Lf
MwC3
RcB
CaB
Mp
Ar
OtC3
OpC
Mm
CaP
0
1 Mile
Scale 1:20 000
0
5000 Feet

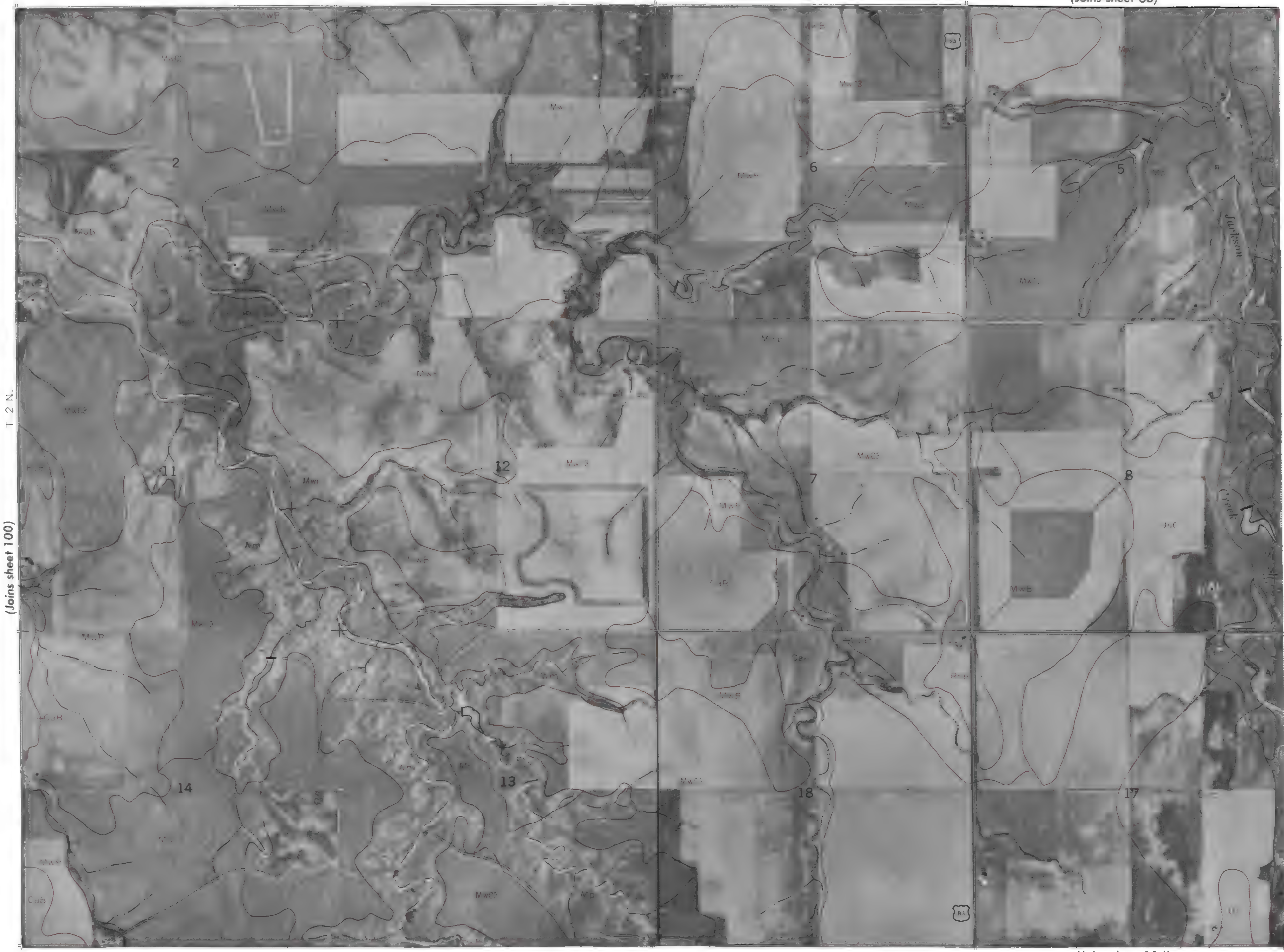
R. 20 E. | R. 21 E.

(Joins sheet 88)

101

T. 2 N.

(Joins sheet 100)



(Joins sheet 102)

(Joins sheet 114)

N

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

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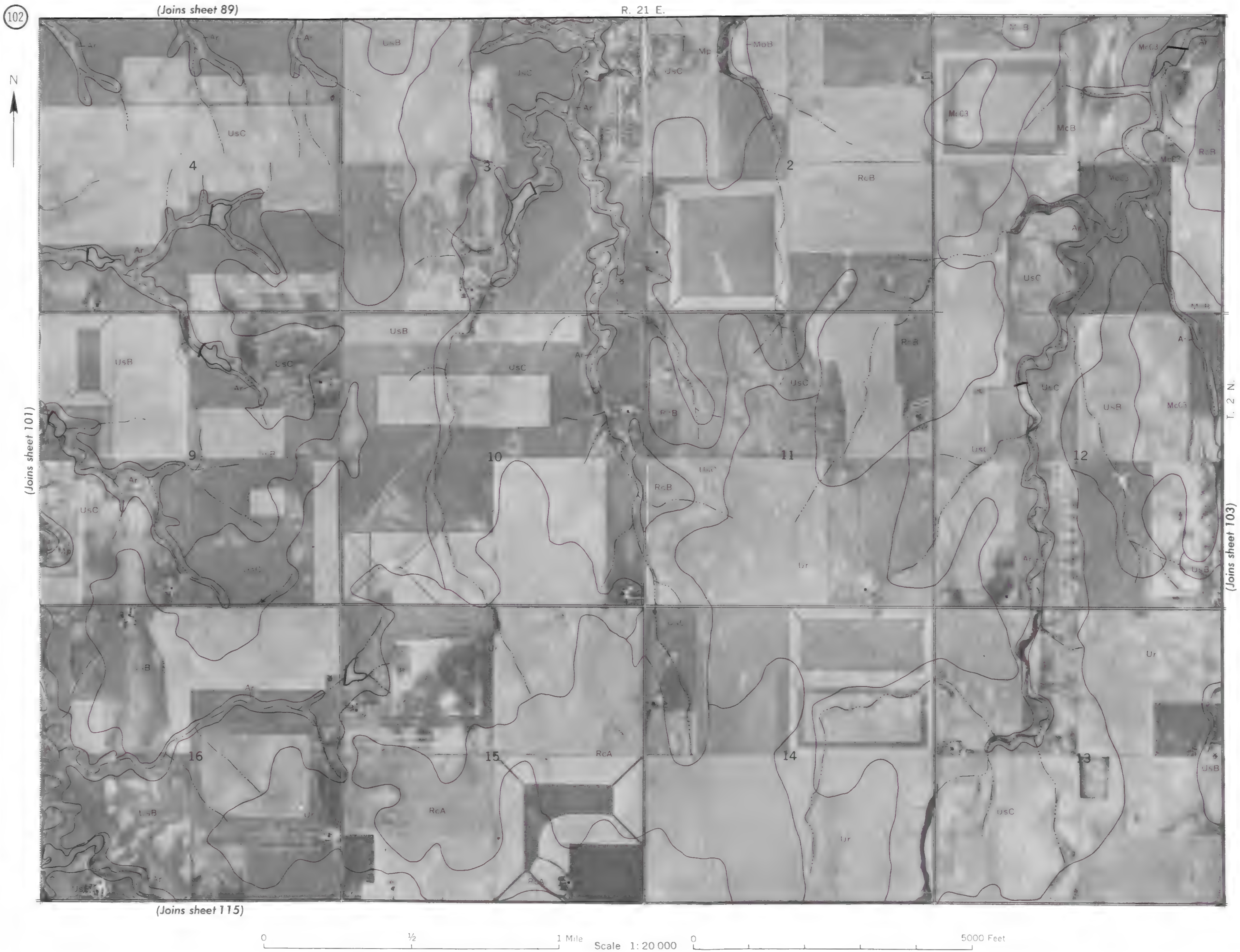
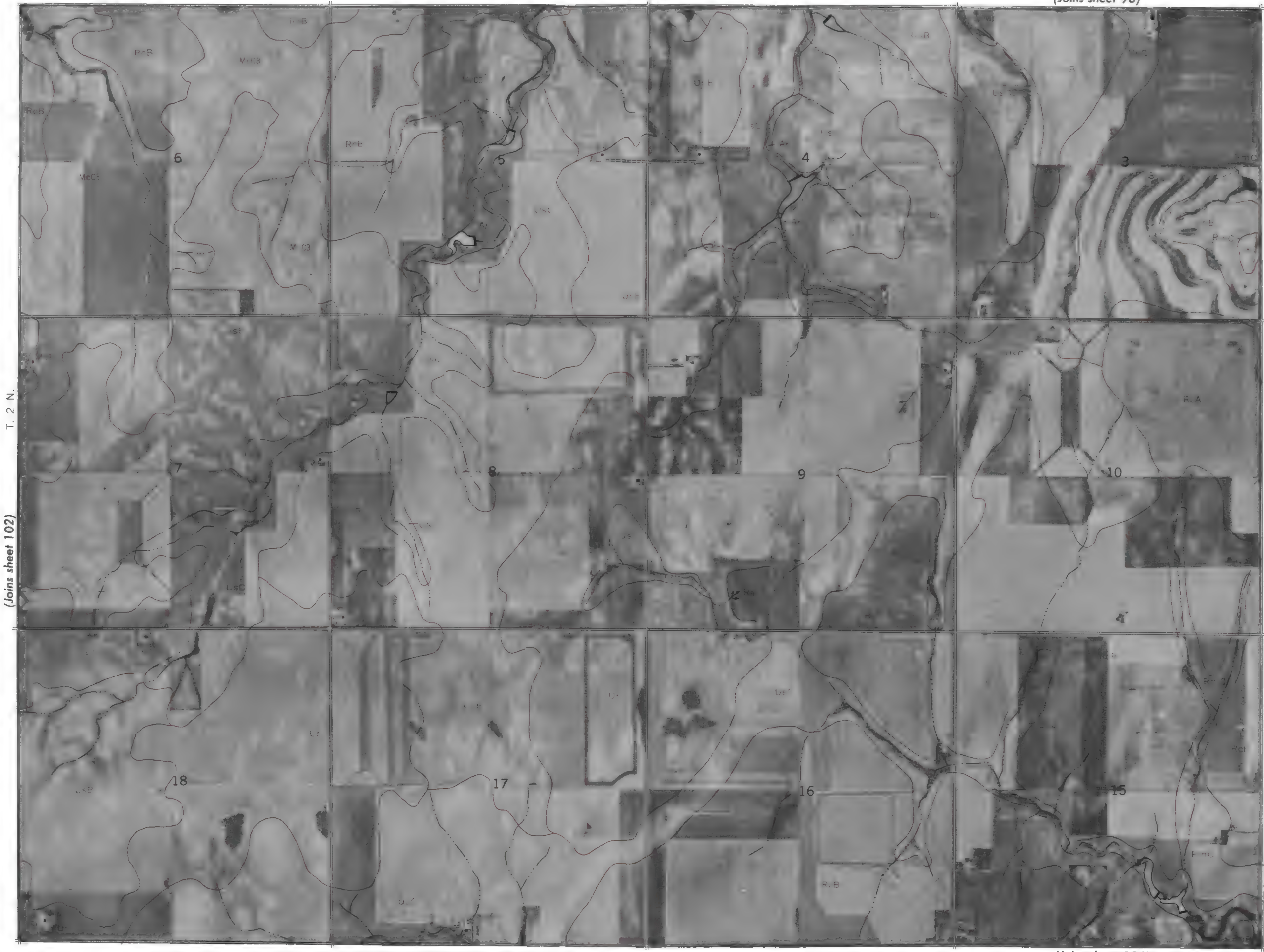

102
(Joins sheet 89)
R. 21 E.
N
(Joins sheet 101)
(Joins sheet 103)
T. 2 N.
(Joins sheet 115)
4
3
2
1
9
10
11
12
16
15
14
13
UsC
UsB
Ar
McB
McG3
RcB
RcA
Ur
Mp
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 103



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


104
(Joins sheet 91)
R. 22 E. | R. 23 E.
N
(Joins sheet 103)
(Joins sheet 105)
(Joins sheet 117)
T. 2 N.
Clear
Creek
Fork
North
RcB
RmC
MaC
UsB
RcA
McC3
McC4
McC2
Mp
Ar
Ln
BoB
1
2
5
6
7
8
11
12
13
14
17
18
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 105

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite.

106

(Joins sheet 93)

R. 24 E.

N

(Joins sheet 105)

(Joins sheet 107)

T. 2 N.

(Joins sheet 119)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

R. 24 E. | R. 25 E.

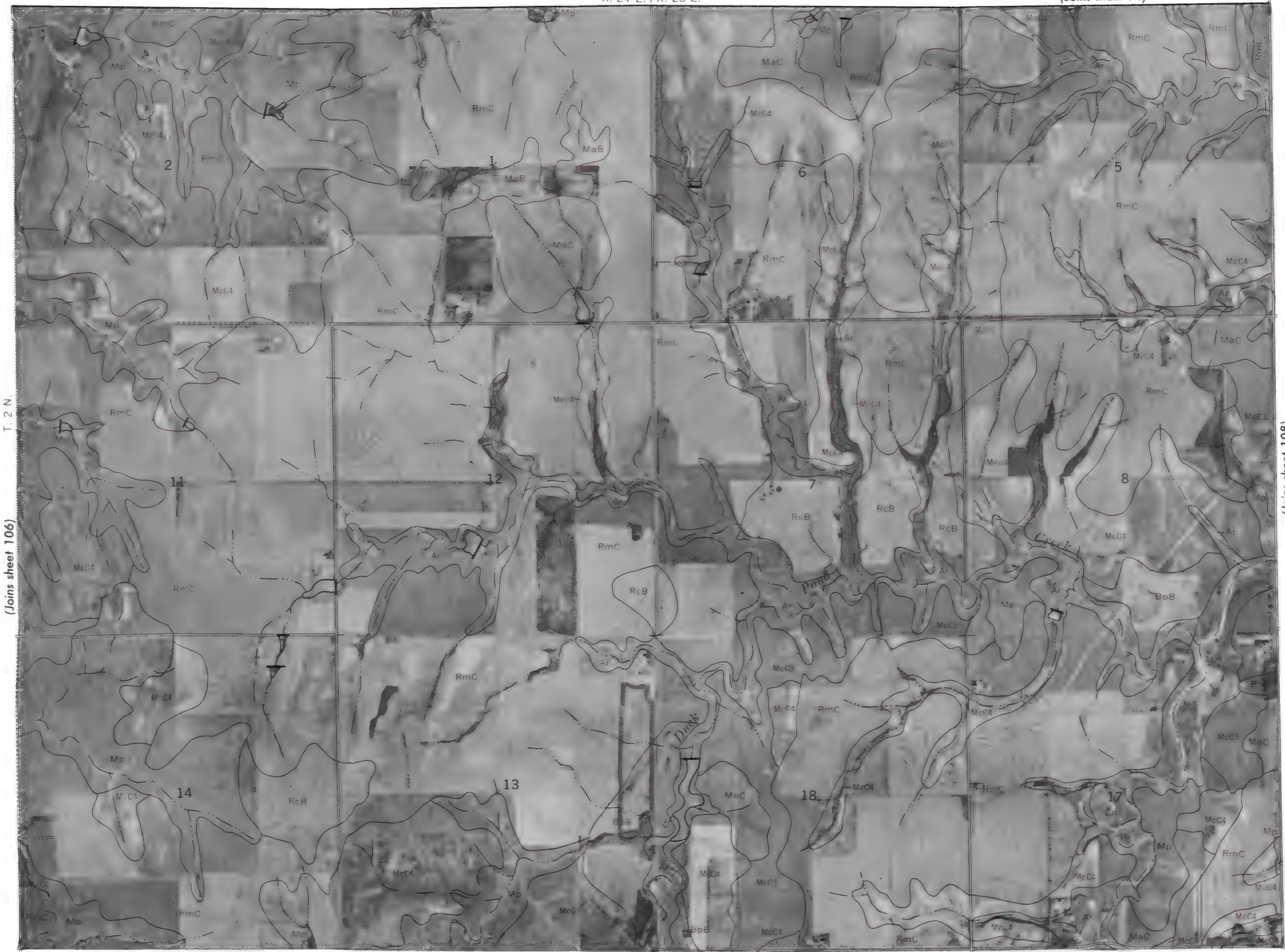
(Joins sheet 94)

107

N

T. 2 N.

(Joins sheet 106)



(Joins sheet 108)

(Joins sheet 120)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

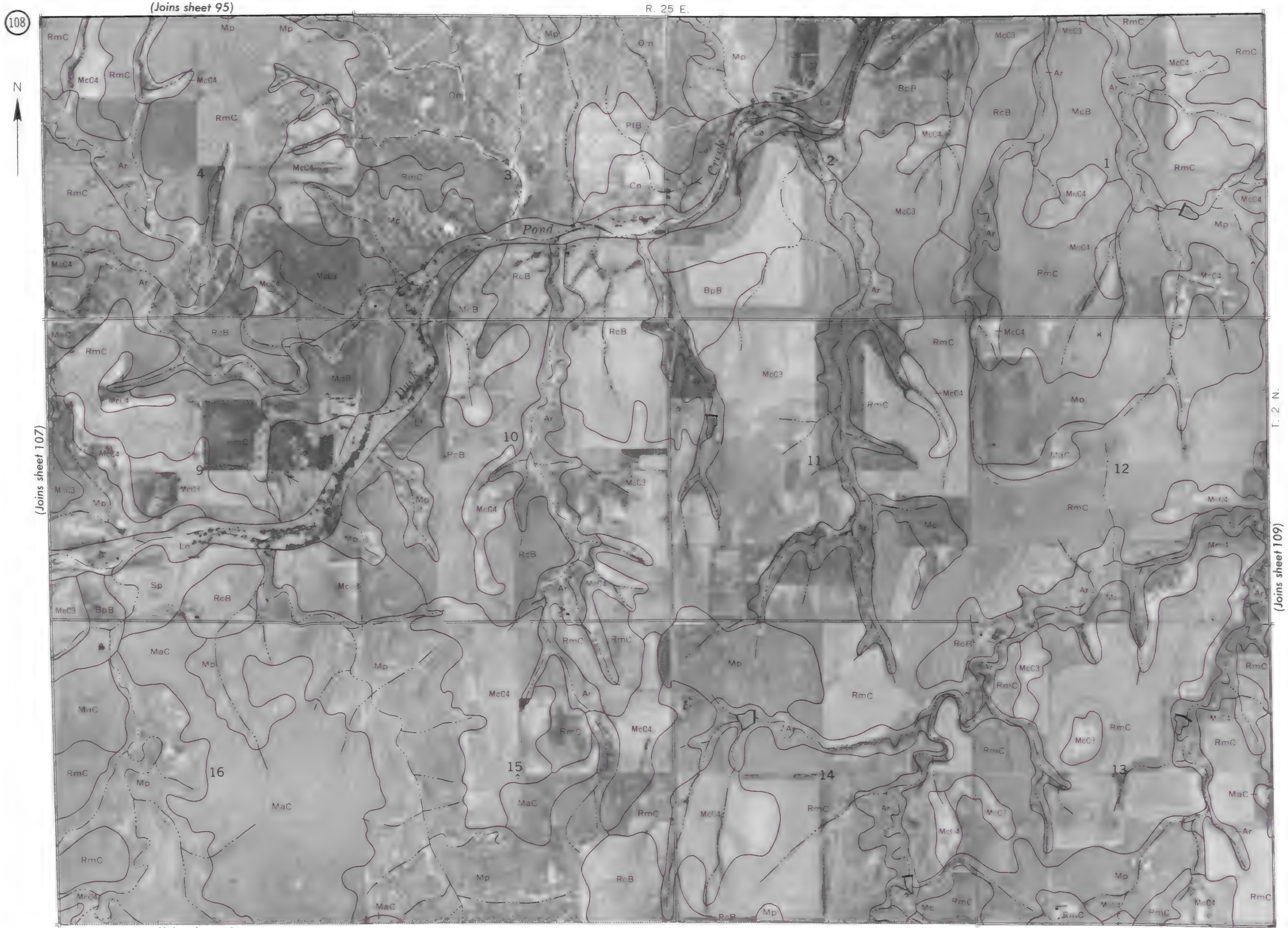
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

108

(Joins sheet 95)

R. 25 E.



(Joins sheet 107)

(Joins sheet 109)

(Joins sheet 121)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 109

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

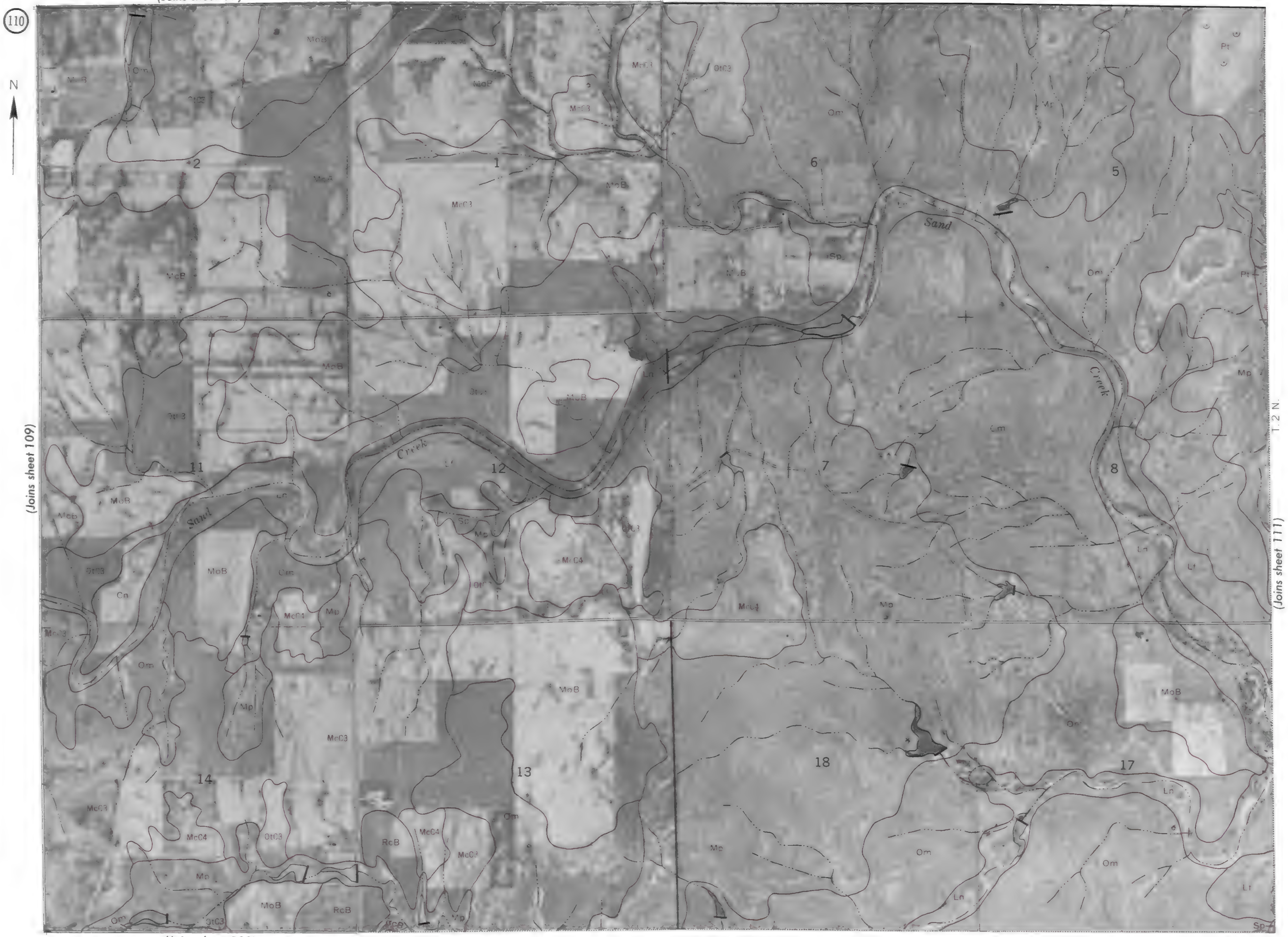
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 110

R. 26 E. | R. 27 E.

(Joins sheet 97)



(Joins sheet 109)

(Joins sheet 111)

(Joins sheet 123)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 27 E.

(Joins sheet 98)

111

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

T. 2 N.

(Joins sheet 110)

(Joins sheet 112)

(Joins sheet 124)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

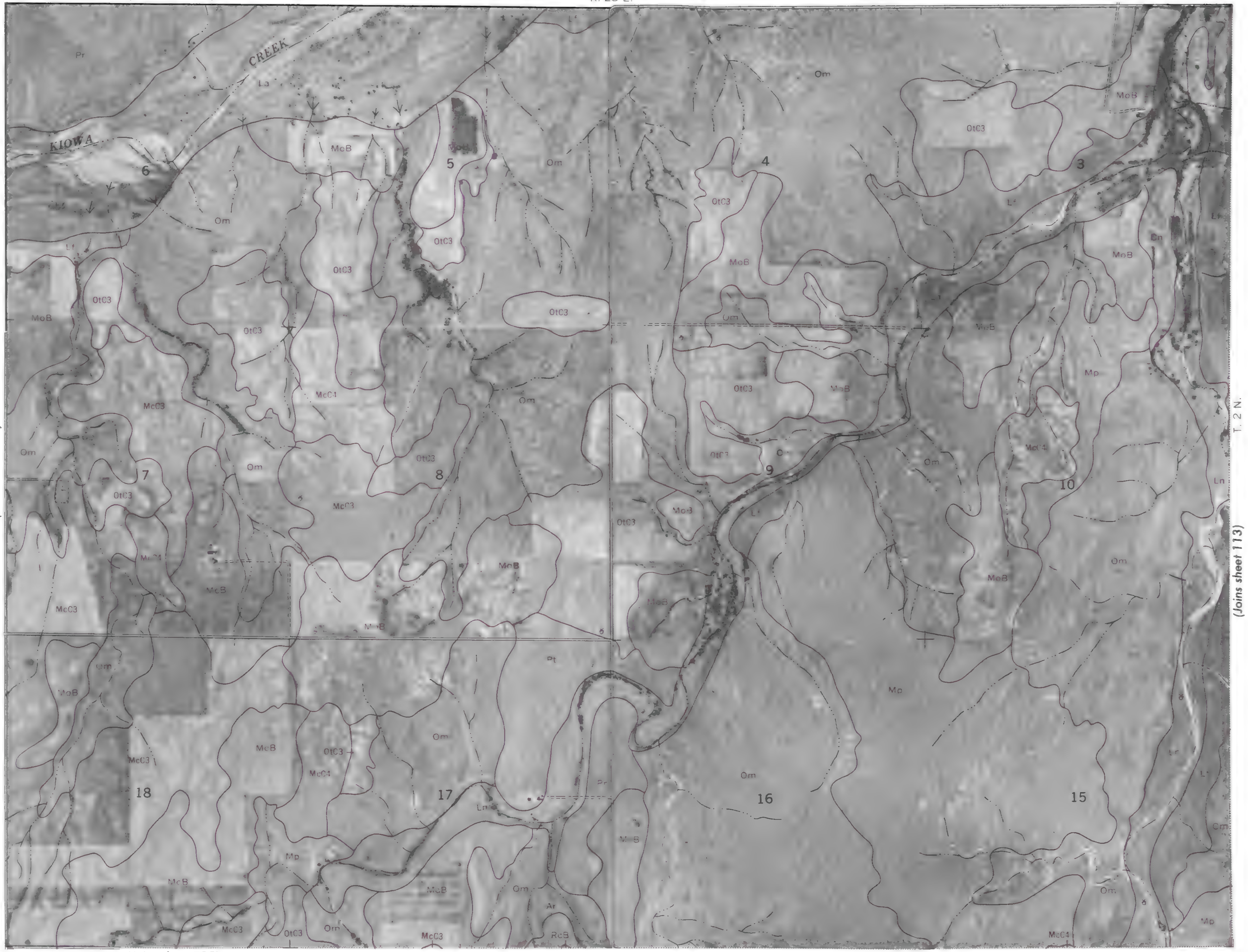
112

(Joins sheet 99)

R. 28 E.

N

(Joins sheet 111)



T. 2 N.

(Joins sheet 113)

(Joins sheet 125)

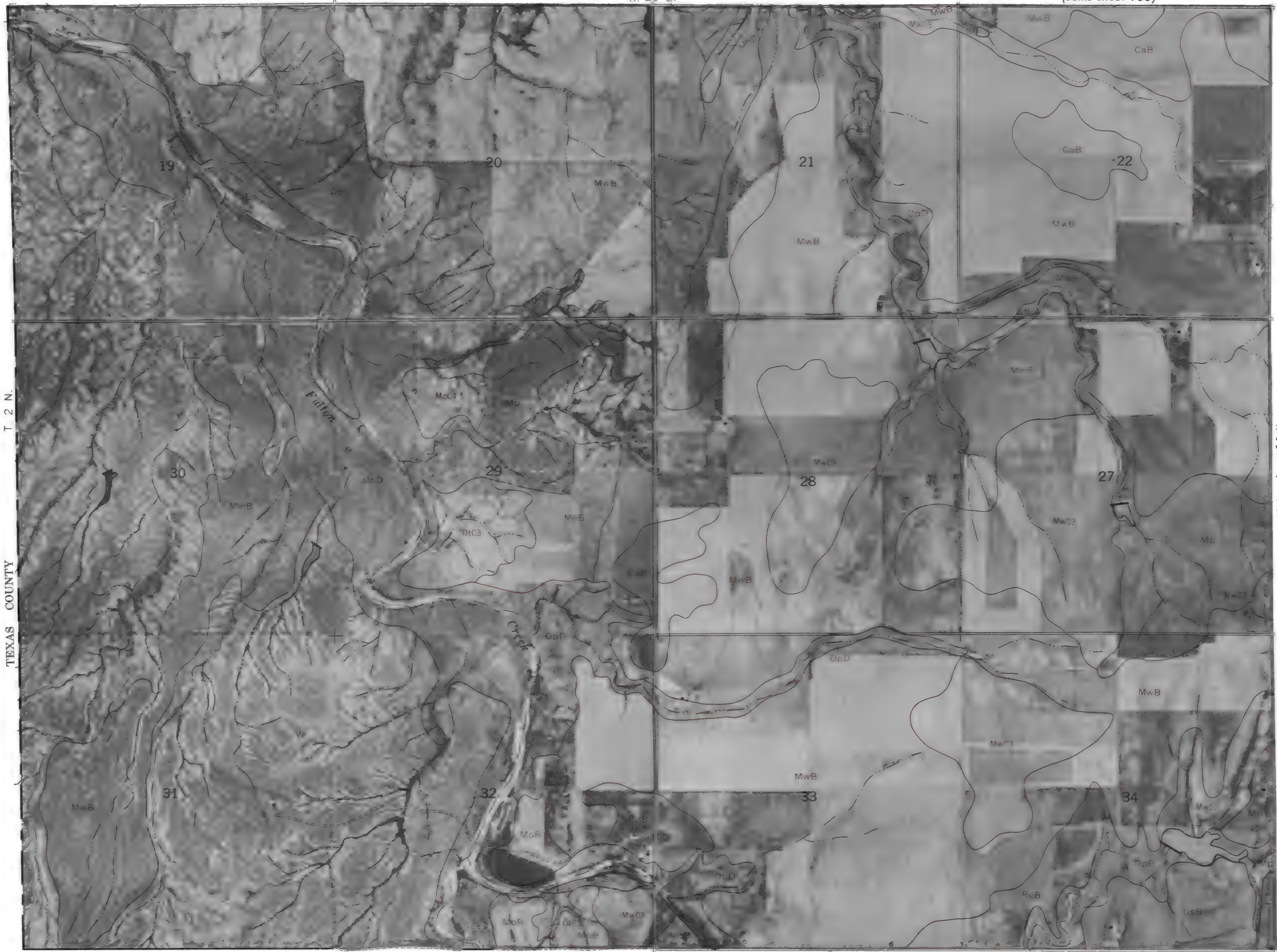
0 1/2 1 Mile Scale 1: 20 000 0 5000 Feet

R. 20 E. *(Joins sheet 100)* 113

N

T 2 N.

TEXAS COUNTY



(Joins sheet 114)

(Joins sheet 127)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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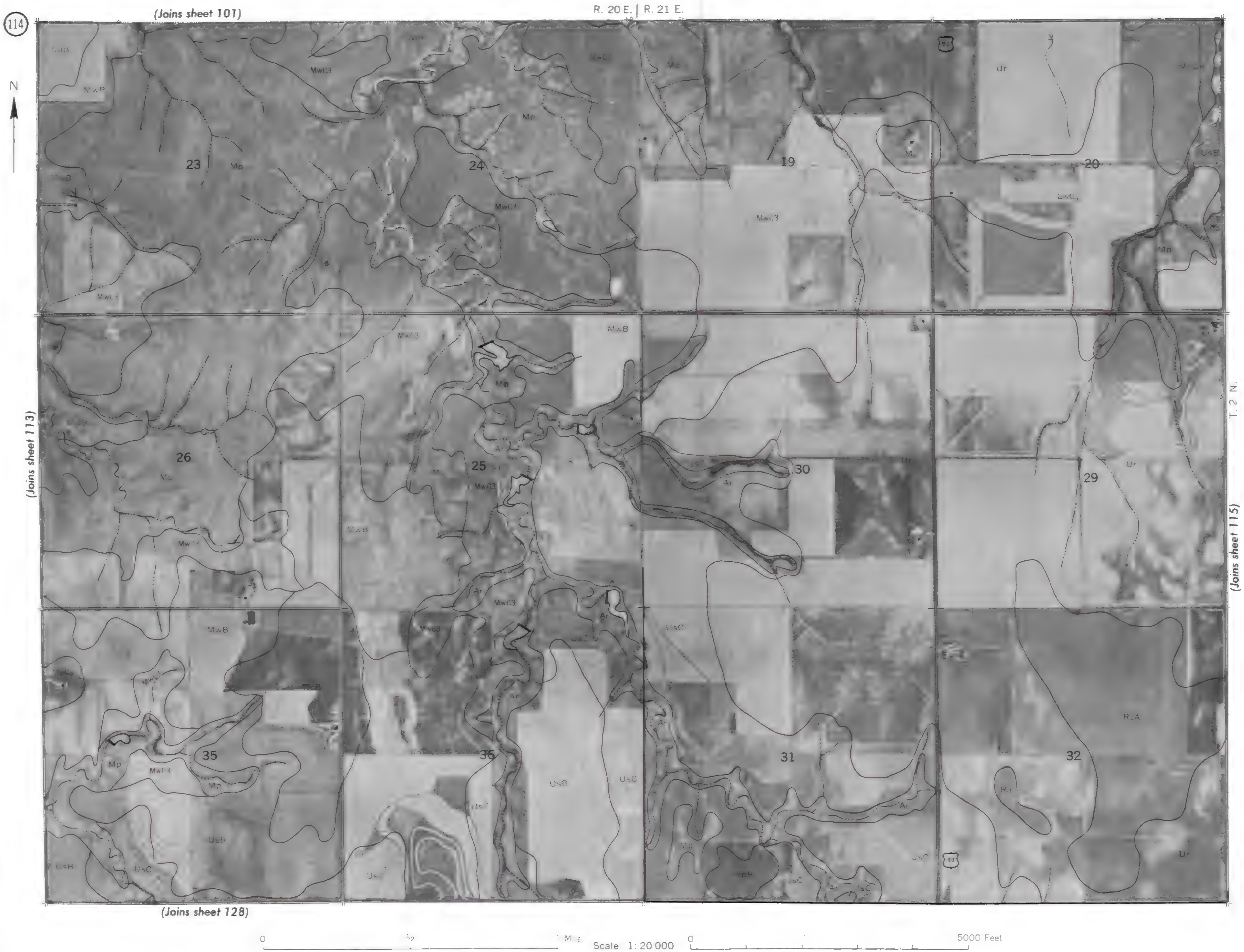

114
(Joins sheet 101)
R. 20 E. | R. 21 E.
N
(Joins sheet 113)
(Joins sheet 115)
T. 2 N.
(Joins sheet 128)
23
24
19
20
26
25
30
29
35
36
31
32
MwB
MwC3
Mp
Ur
UsC
UsB
Ar
RtA
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

R. 21 E.

(Joins sheet 102)

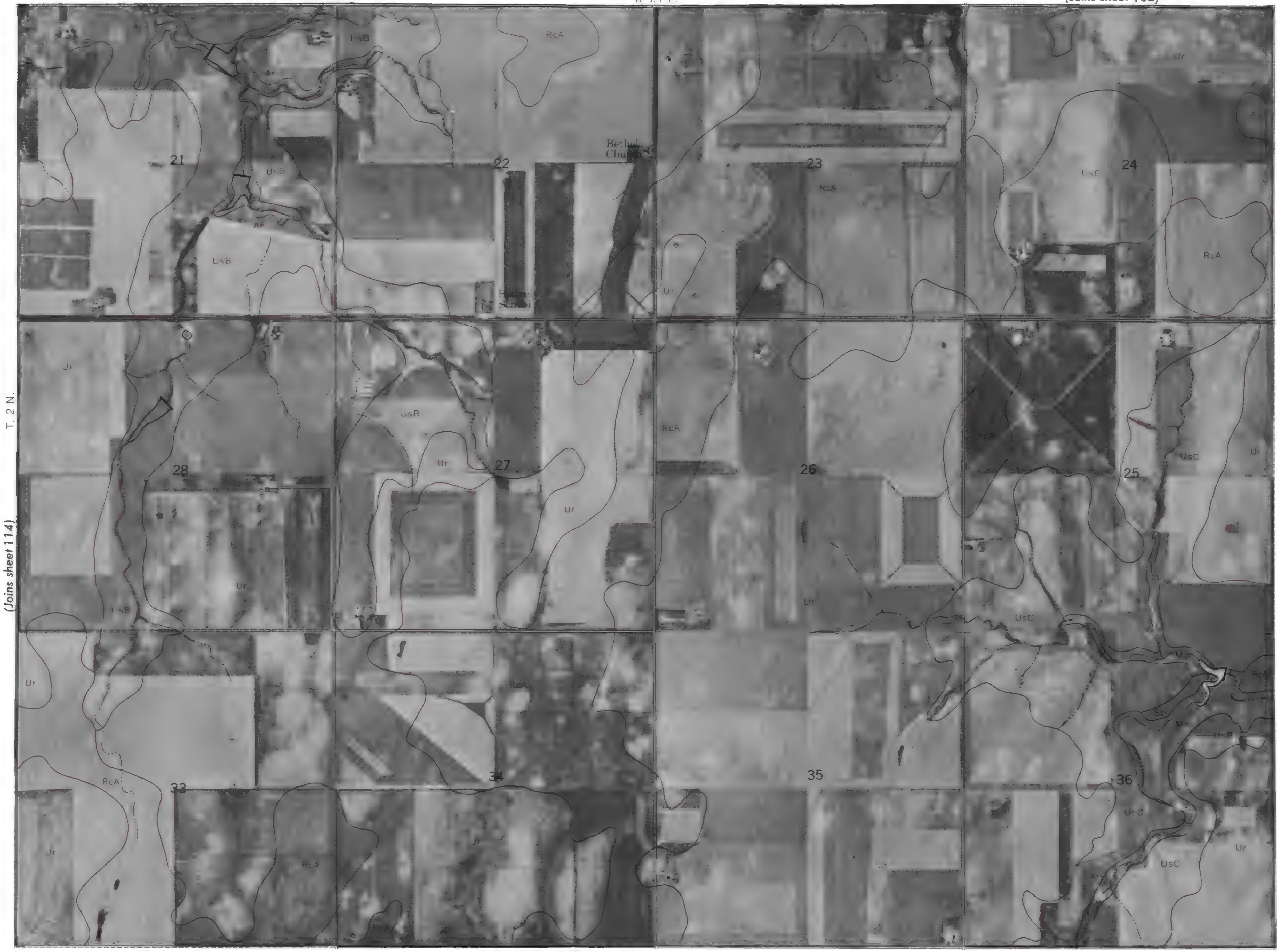
115

N

T. 2 N.

(Joins sheet 114)

(Joins sheet 116)



(Joins sheet 129)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


116
(Joins sheet 103)
R. 22 E.
N
Balko
(Joins sheet 115)
(Joins sheet 117)
T. 2 N.
(Joins sheet 130)
19
20
21
22
30
29
28
27
31
32
33
34
Ur
UsC
UsB
ReB
BpB
MaC
McC4
Coal
Creek
Fork
North
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs taken in [illegible]

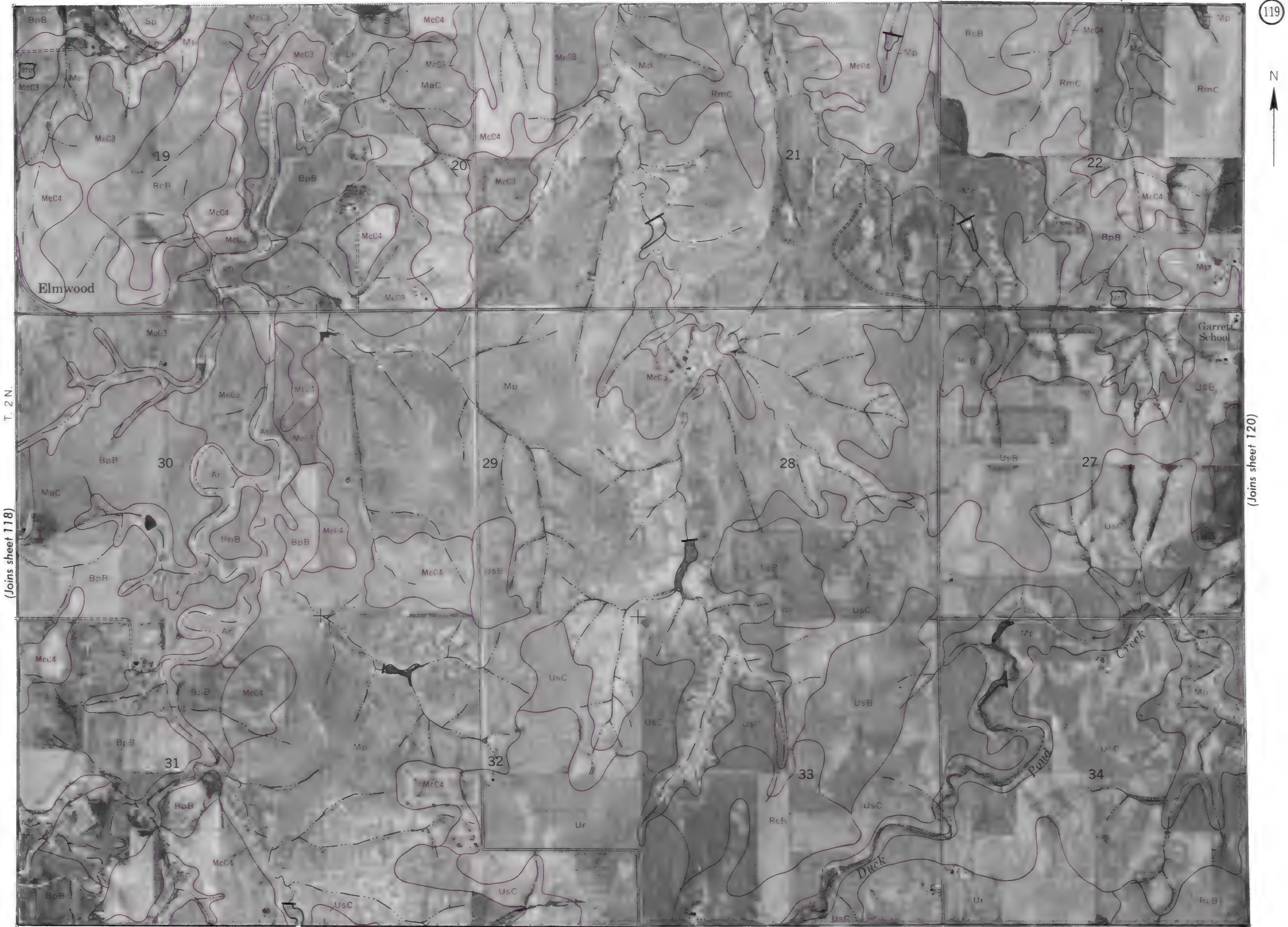
Range, township, and section corners shown on this map are indefinite.

Scale 1:20 000 0 5000 Feet


118
(Joins sheet 105)
R. 23 E.
N
(Joins sheet 117)
(Joins sheet 119)
T. 2 N.
(Joins sheet 132)
Clear
South
Fork
Creek
Elmwood
21
22
23
24
28
27
26
25
33
34
35
36
RcB
BpB
McC3
McC4
Mp
MaC
RmC
Ar
UsB
UsC
MaB
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

R. 24 E.

(Joins sheet 106)



(Joins sheet 133)

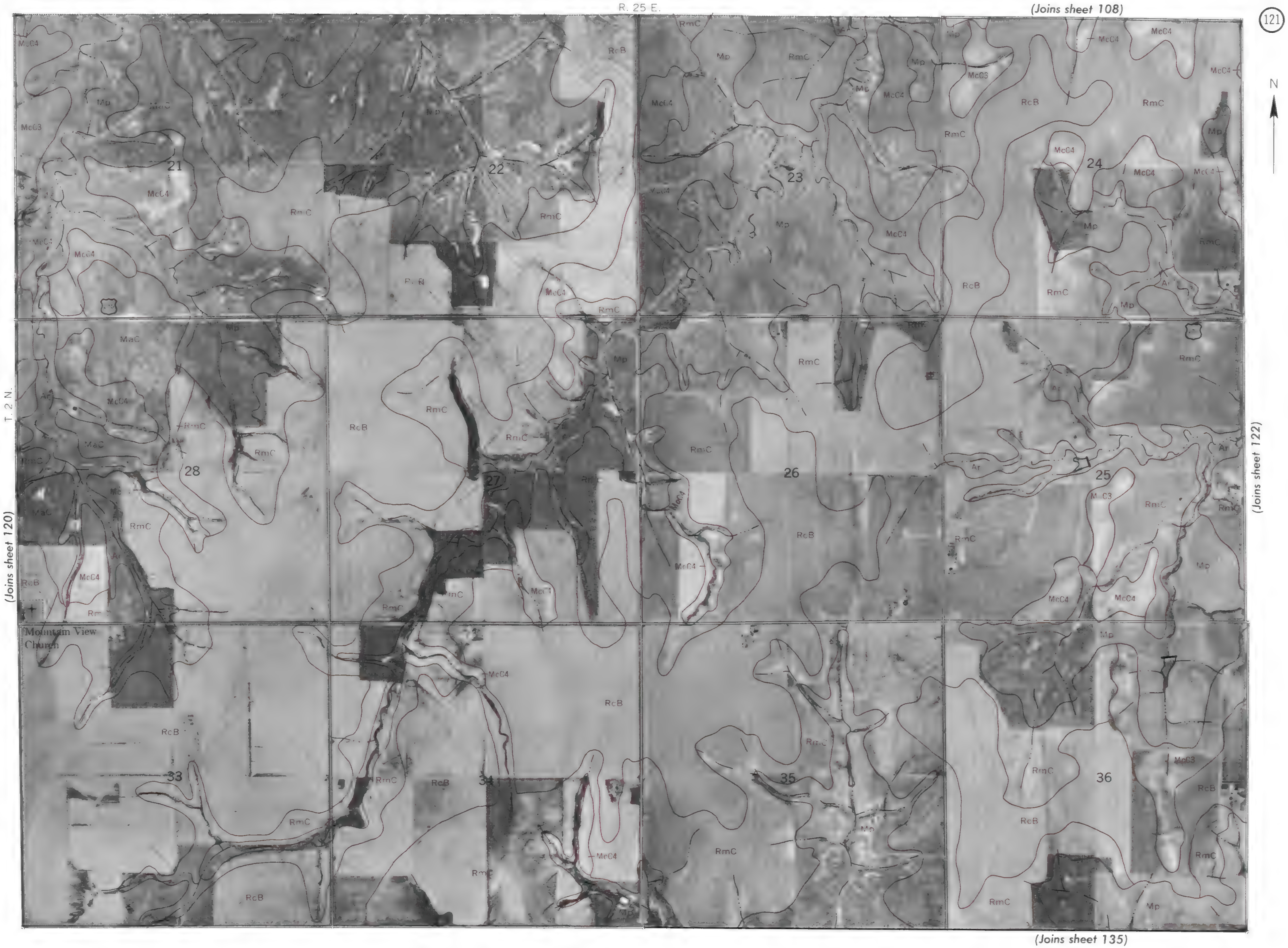
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


R. 22 E. | R. 23 E.
12
(Joins sheet 3)
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 25)
T. 6 N.
N
DaB
PtB
DaA
MaB
OpD
Pt
23
24
19
20
26
25
30
29
35
36
31
32
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet


120
(Joins sheet 107)
R. 24 E. | R. 25 E.
N
(Joins sheet 119)
(Joins sheet 121)
T. 2 N.
(Joins sheet 134)
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet



Scale 1: 20 000

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

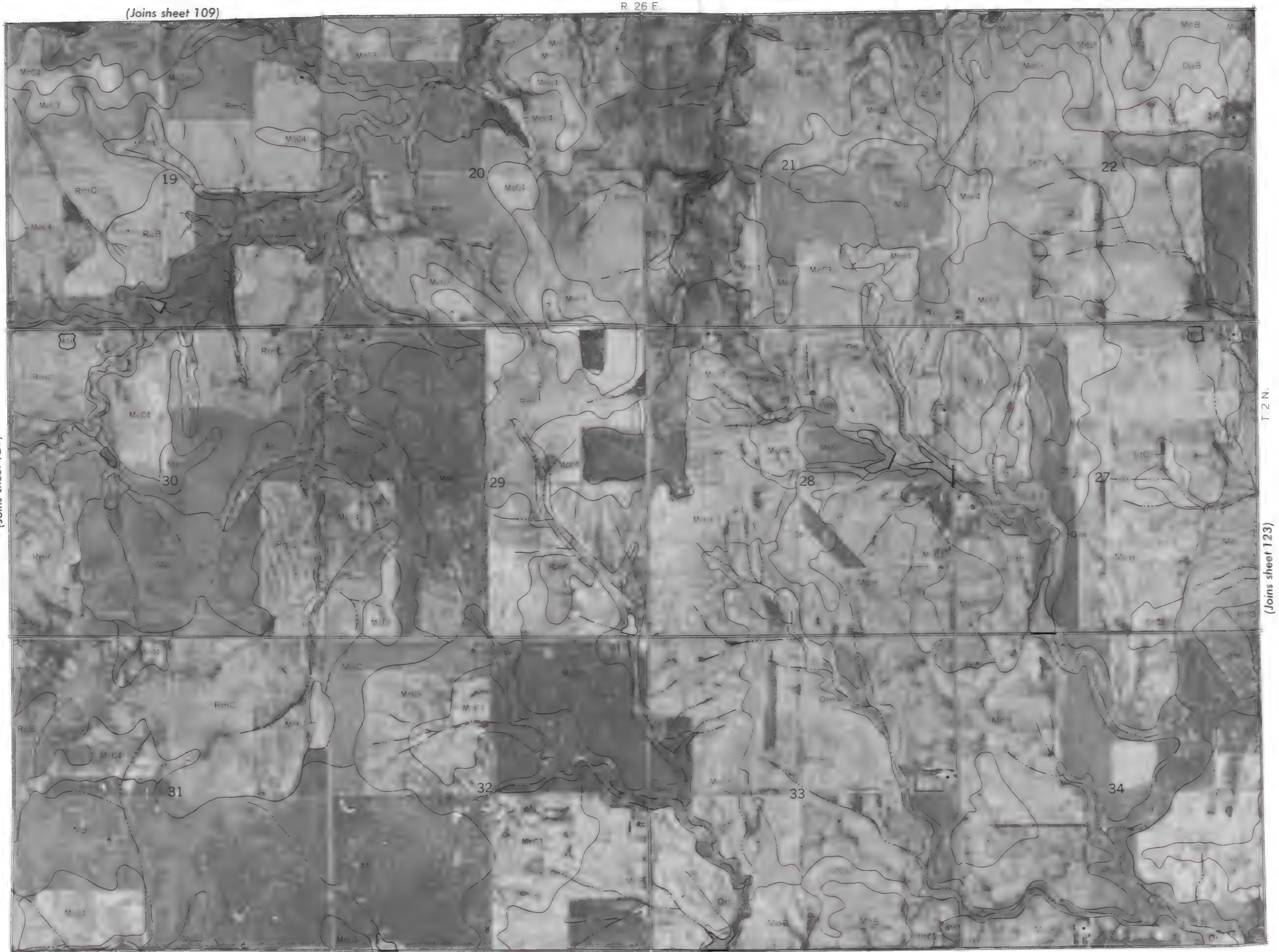
Range, township, and section corners shown on this map are indefinite.

122

(Joins sheet 109)

R. 26 E.

N

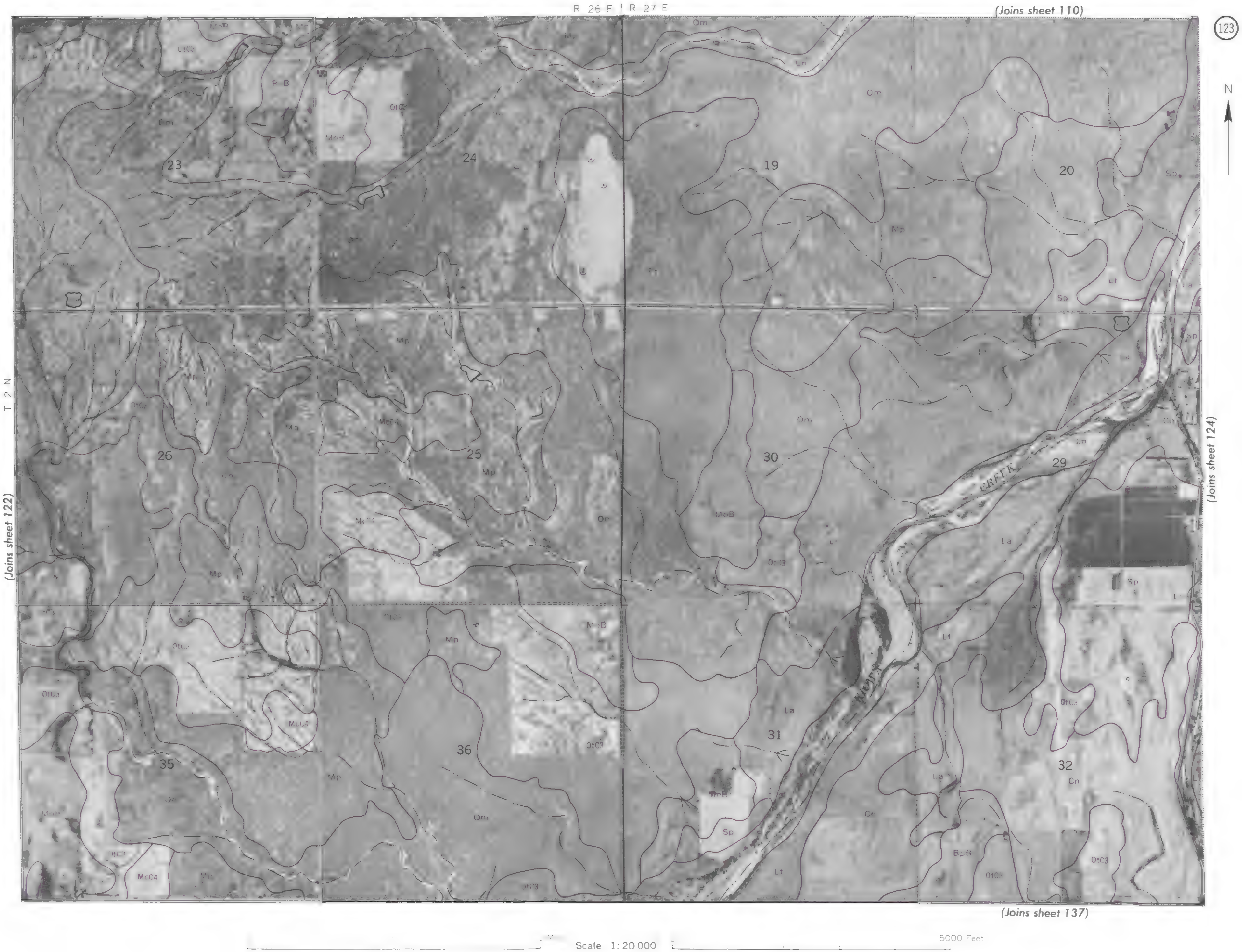


(Joins sheet 121)

(Joins sheet 123)

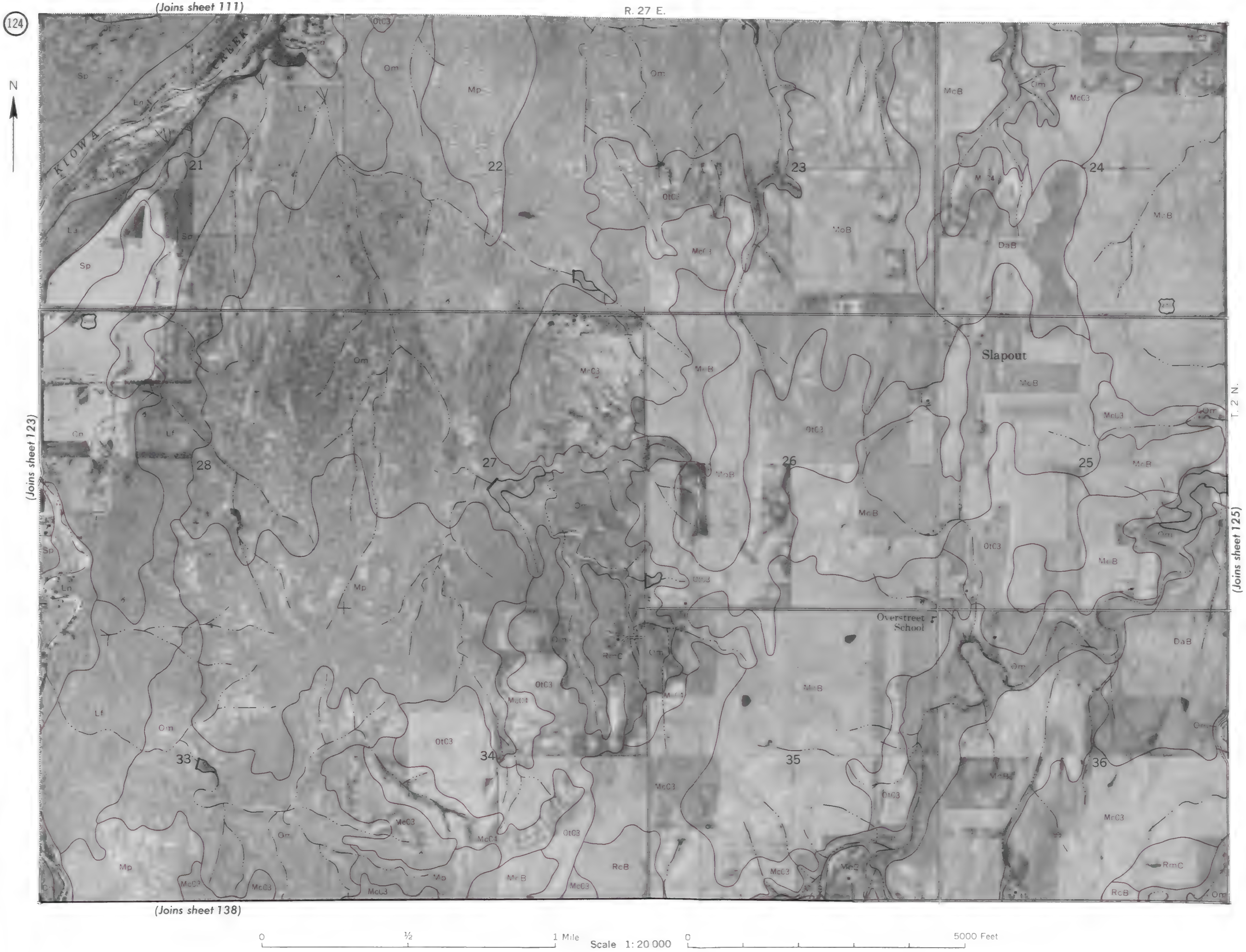
(Joins sheet 136)

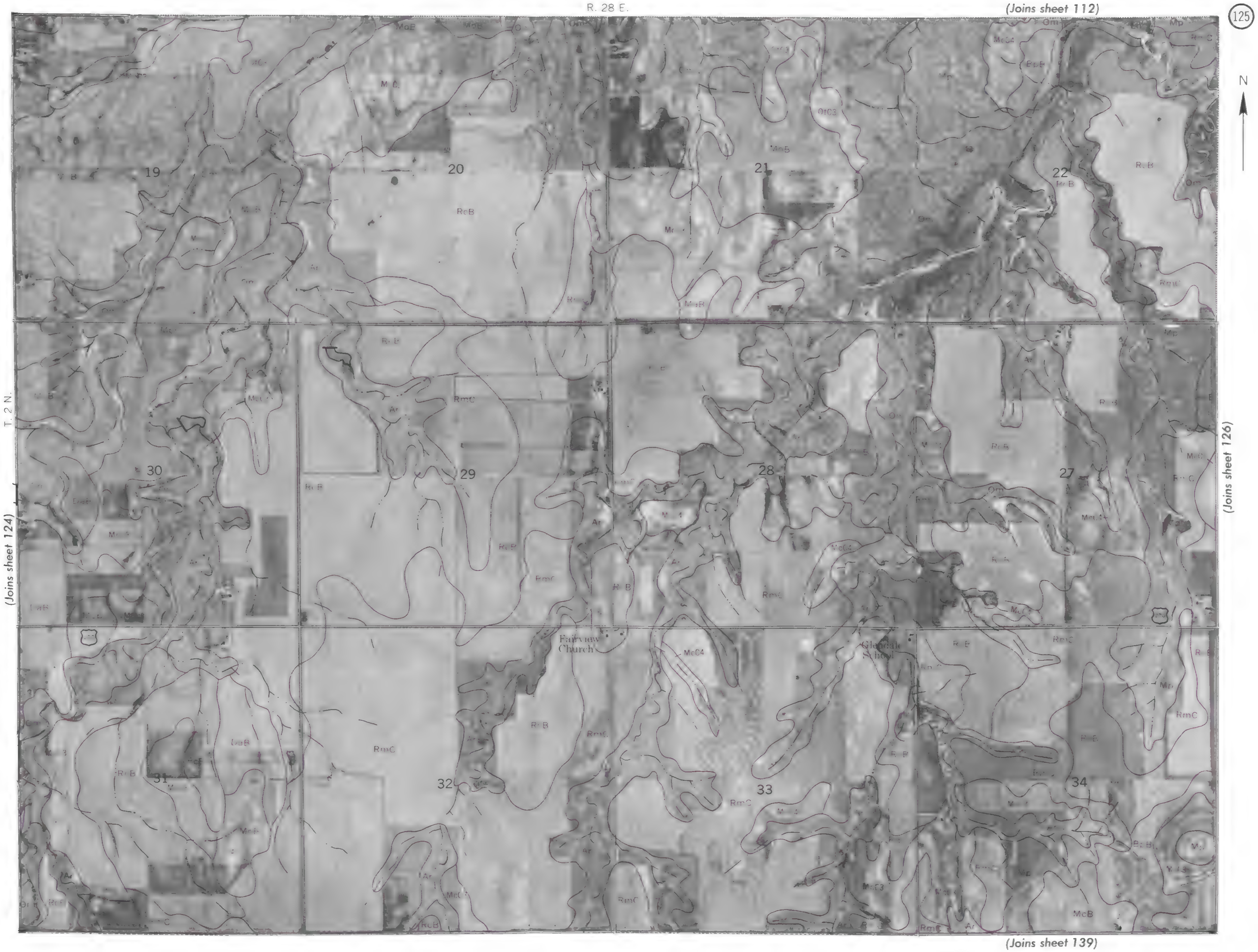
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


124
(Joins sheet 111)
R. 27 E.
N
(Joins sheet 123)
(Joins sheet 125)
T. 2 N.
(Joins sheet 138)
KIOWA CREEK
Slapout
Overstreet School
21
22
23
24
25
26
27
28
33
34
35
36
0
½
1 Mile
Scale 1:20 000
0
5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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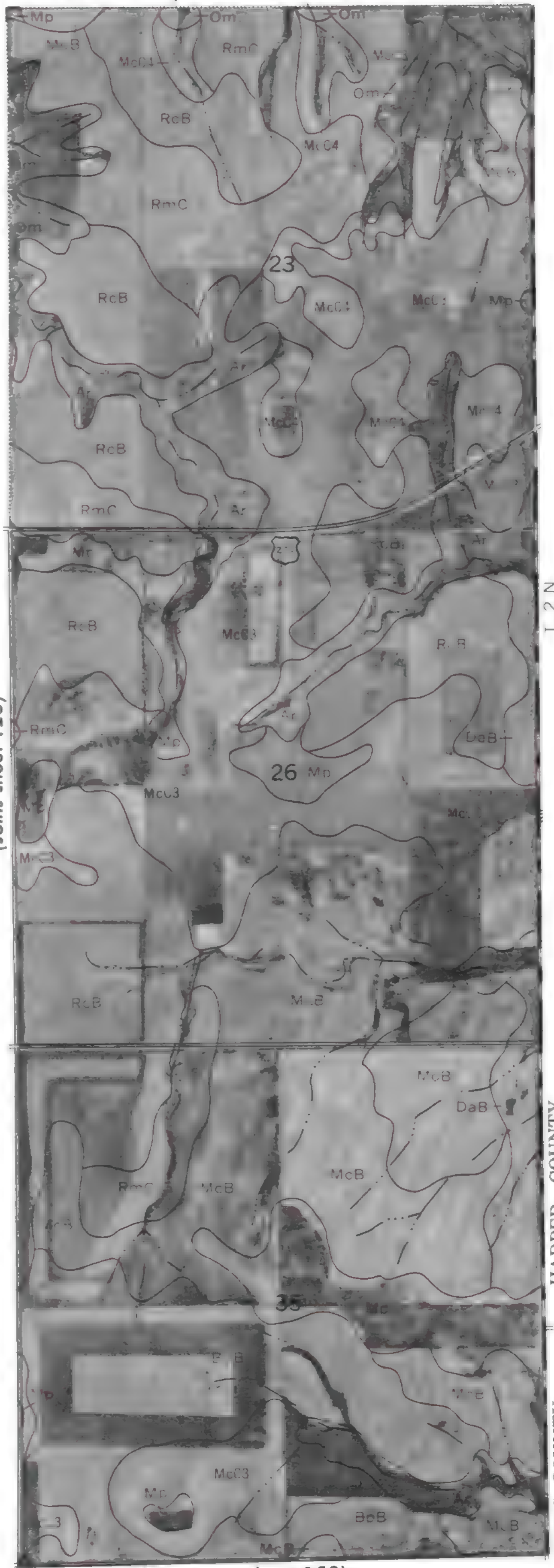
Range, township, and section corners shown on this map are indefinite.

126

N

R. 28 E. (Joins lower center)



T. 2 N.

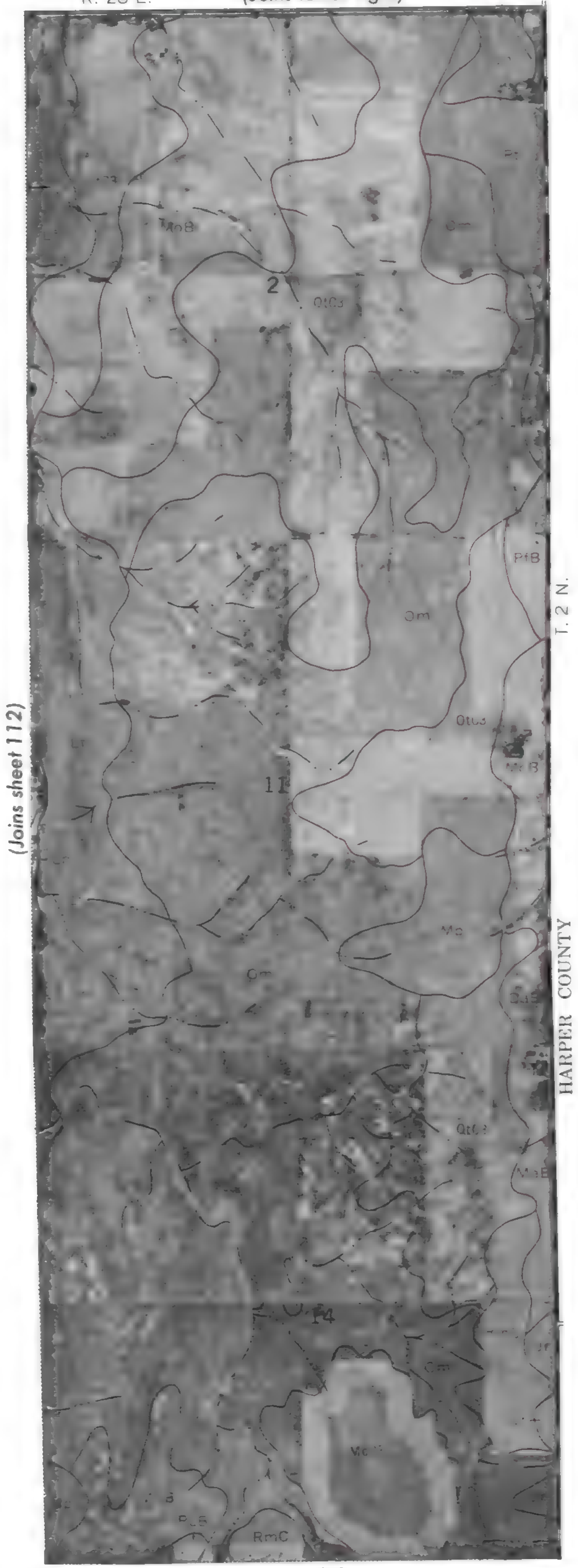
(Joins sheet 125)

HARPER COUNTY

ELLIS COUNTY

(Joins inset, sheet 153)

R. 28 E. (Joins lower right)



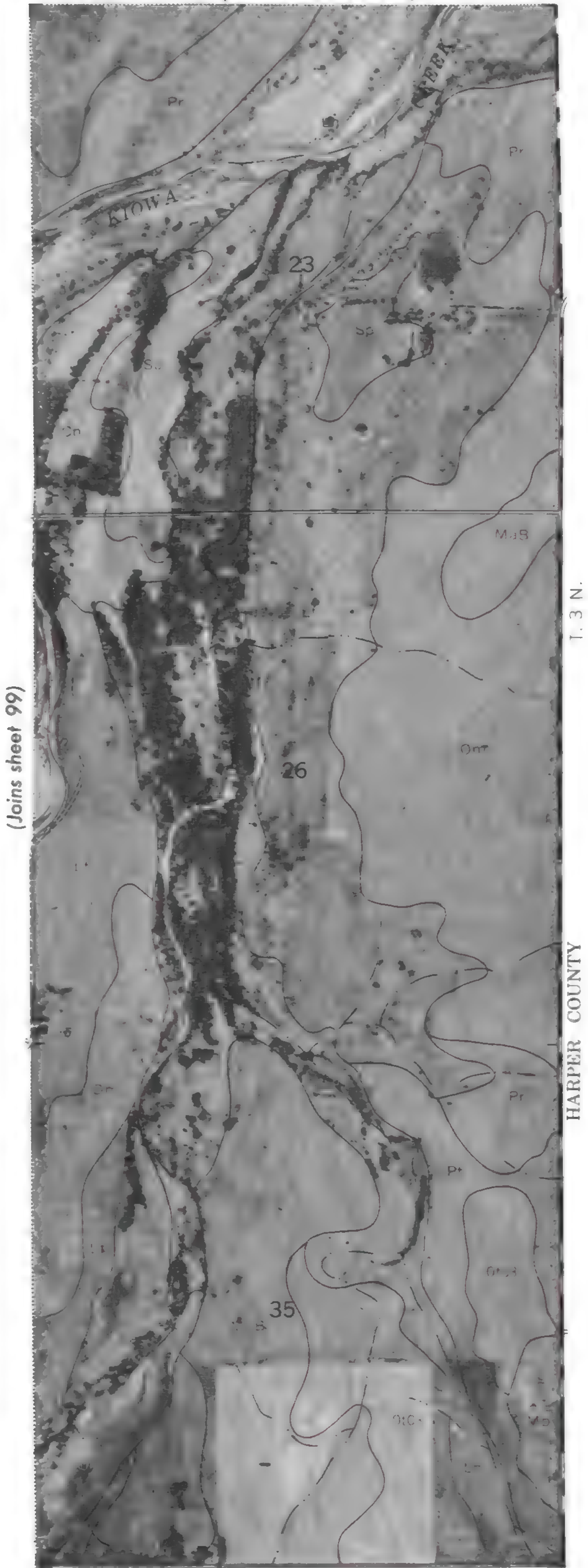
T. 2 N.

(Joins sheet 112)

HARPER COUNTY

(Joins upper left)

R. 28 E. (Joins inset, sheet 86)



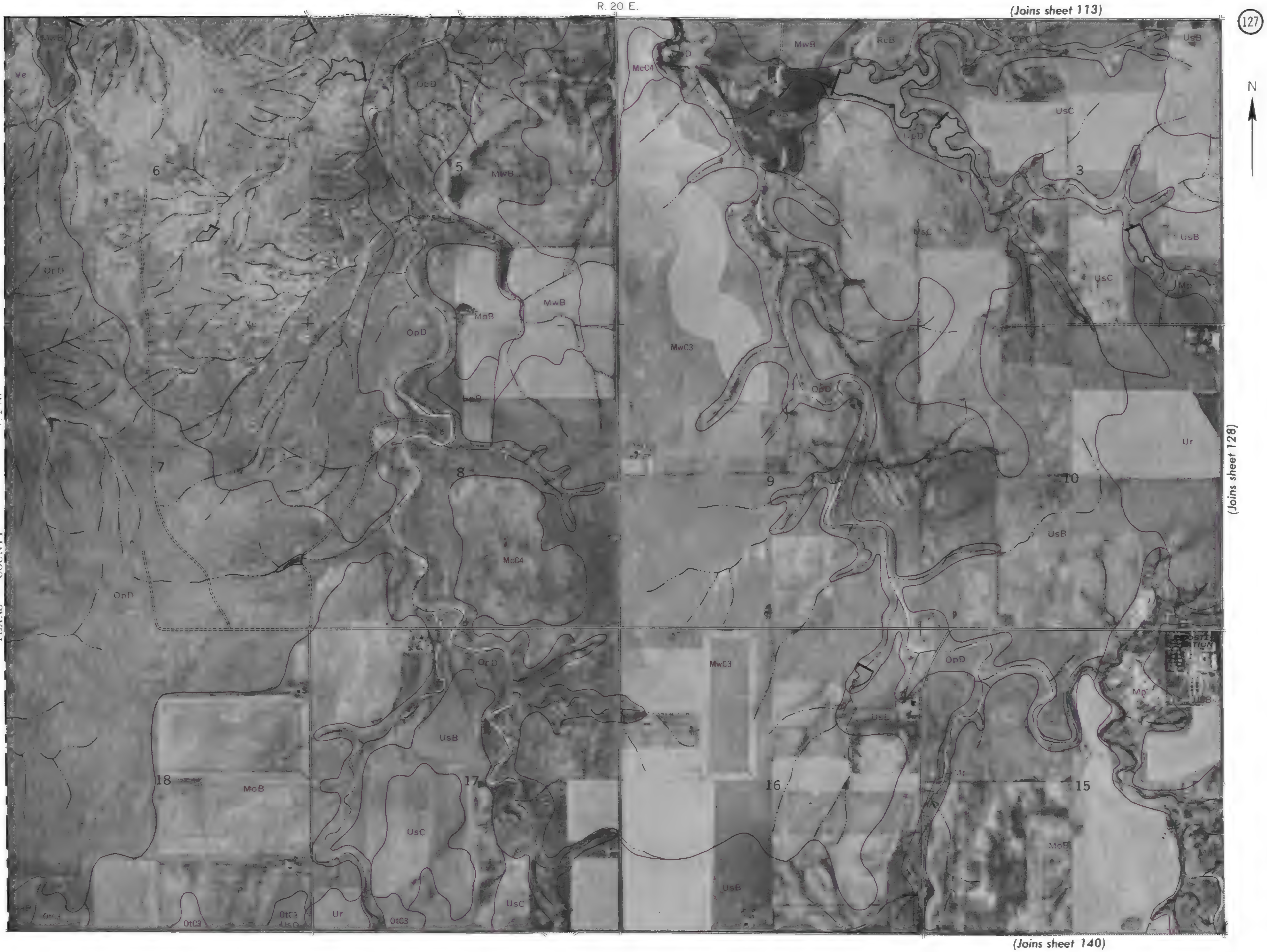
T. 3 N.

(Joins sheet 99)

HARPER COUNTY

(Joins upper center)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1963

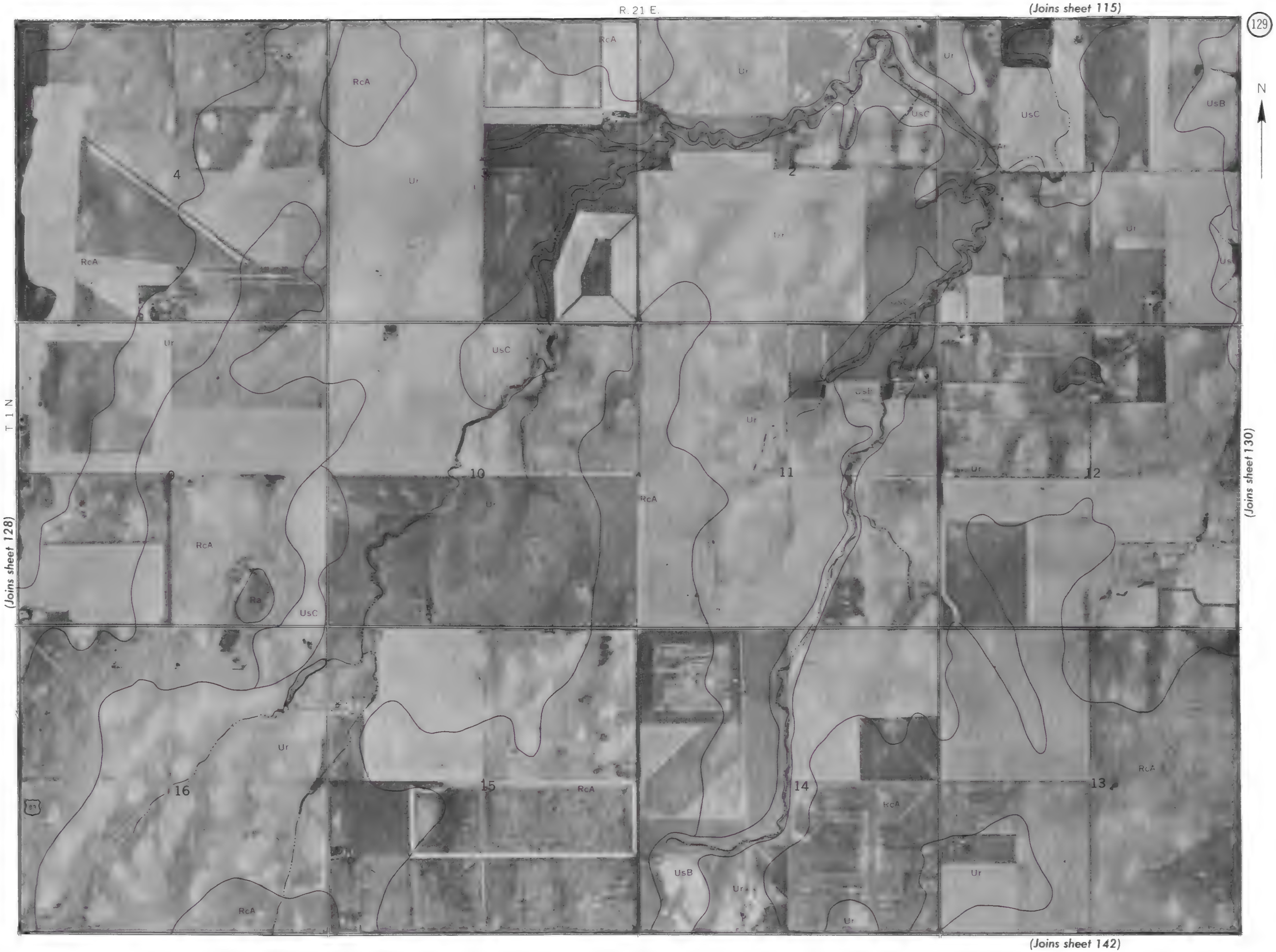
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


128
(Joins sheet 114)
R. 20 E. | R. 21 E.
N
(Joins sheet 127)
(Joins sheet 129)
T. 1 N.
(Joins sheet 141)
2
1
6
5
11
12
7
8
14
13
18
17
Gray
Gray Cemetery
UsC
UsB
Ur
RcA
Mo
0
1/2
1 Mile
Scale 1: 20 000
0
5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

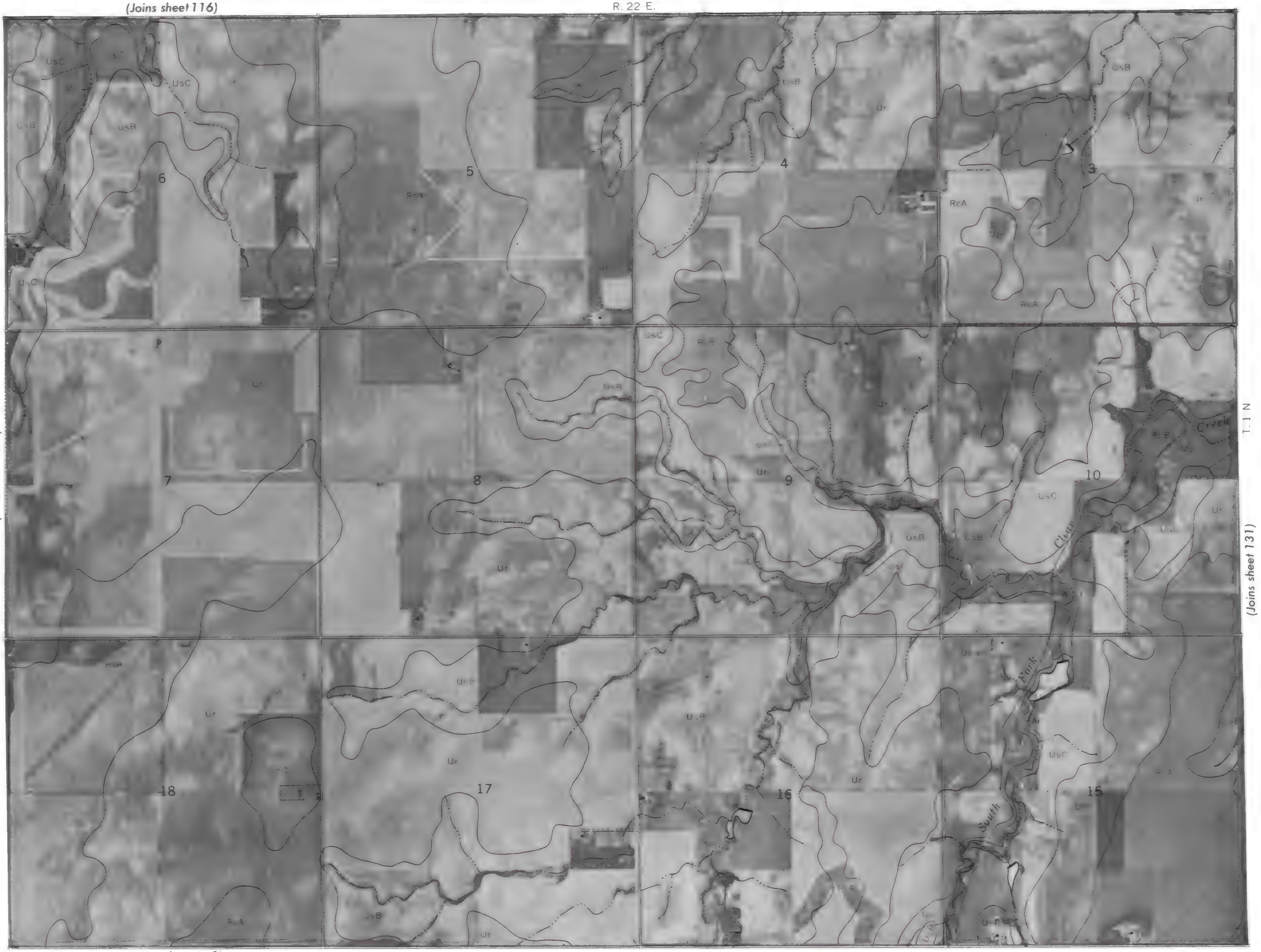
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

130

(Joins sheet 116)

R. 22 E.



(Joins sheet 129)

(Joins sheet 131)

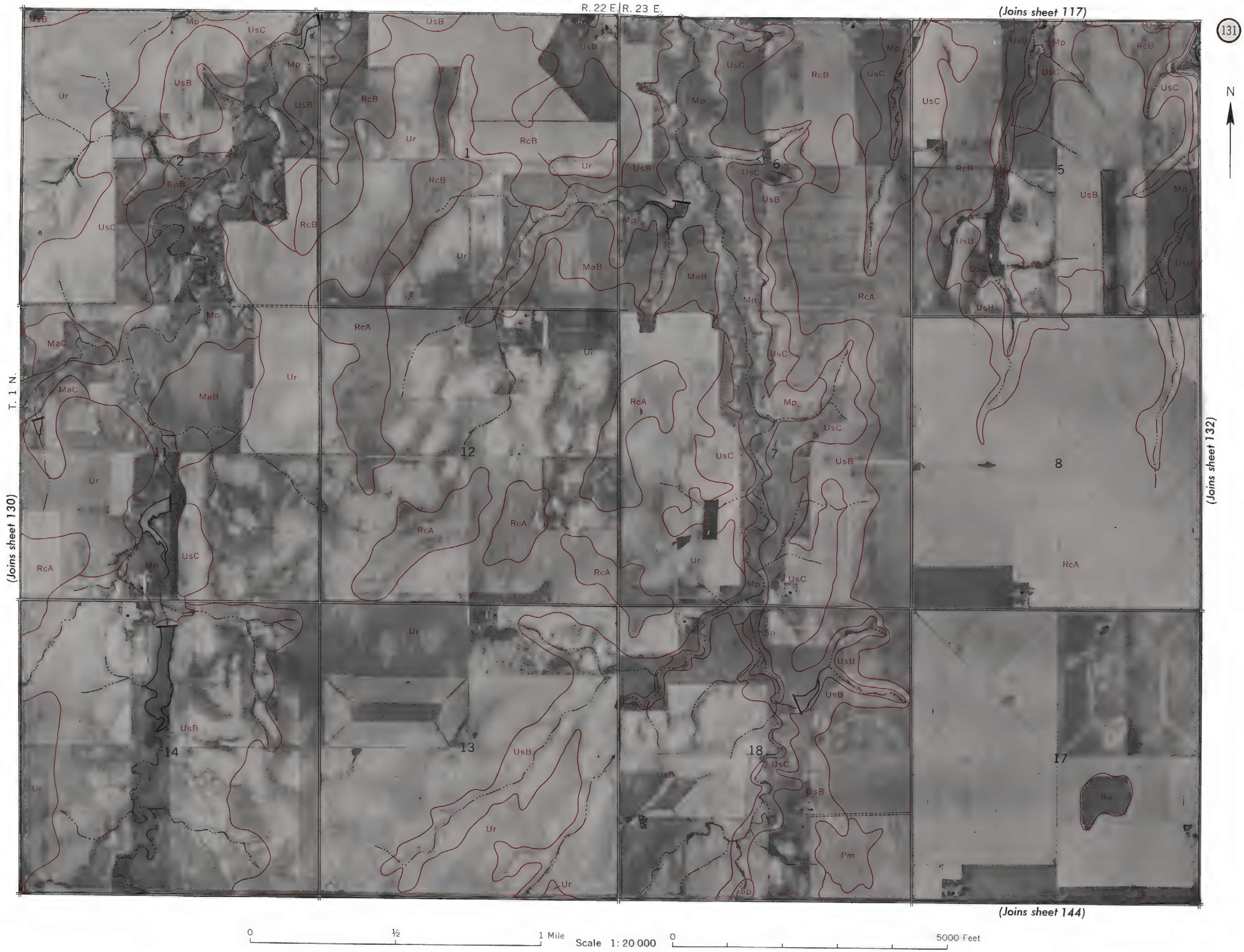
(Joins sheet 143)

Scale 1: 20 000

0

5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 131



BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 132

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 24 E.

(Joins sheet 119)

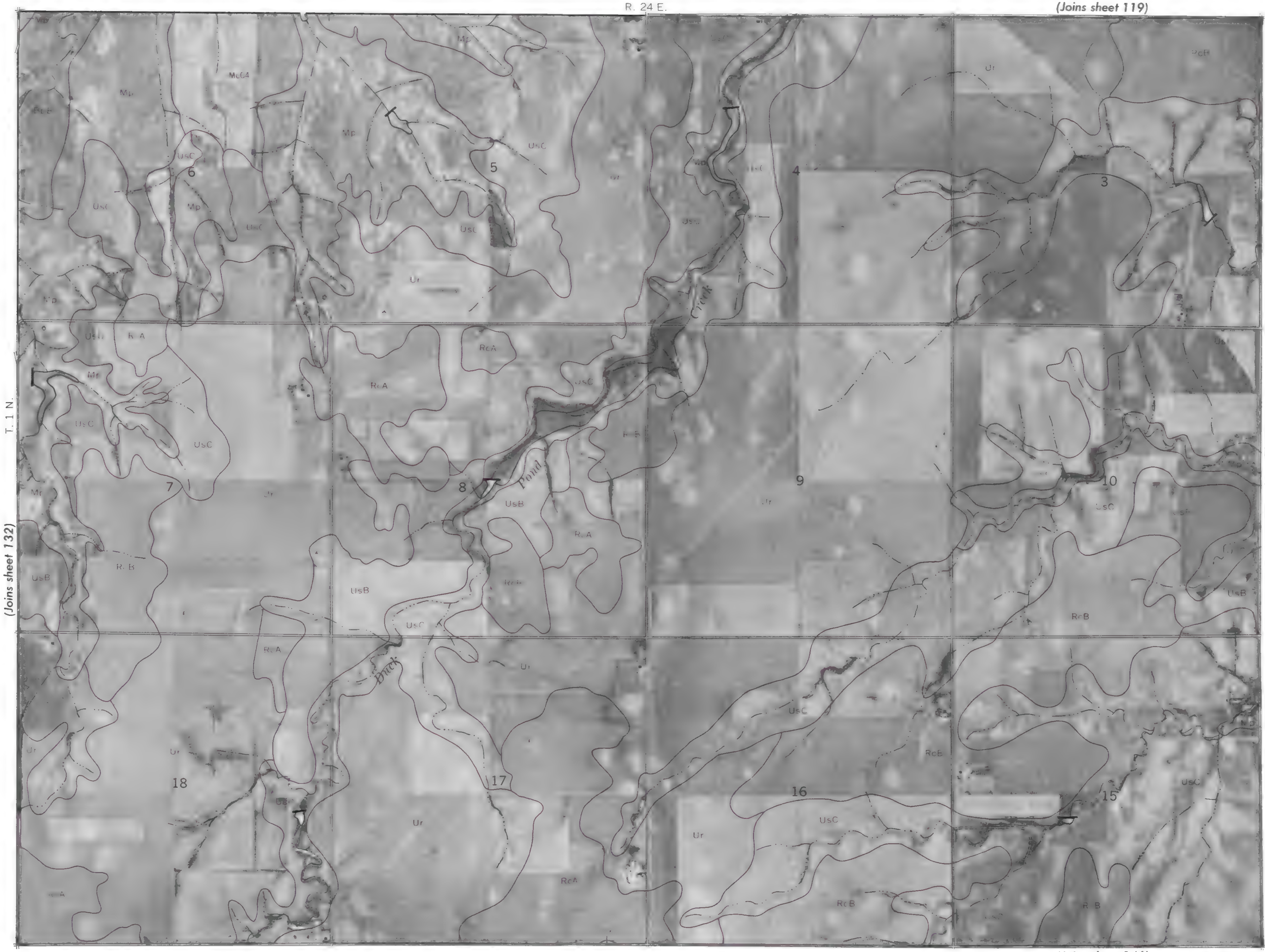
133

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

T. 1 N.

(Joins sheet 132)



(Joins sheet 134)

(Joins sheet 146)

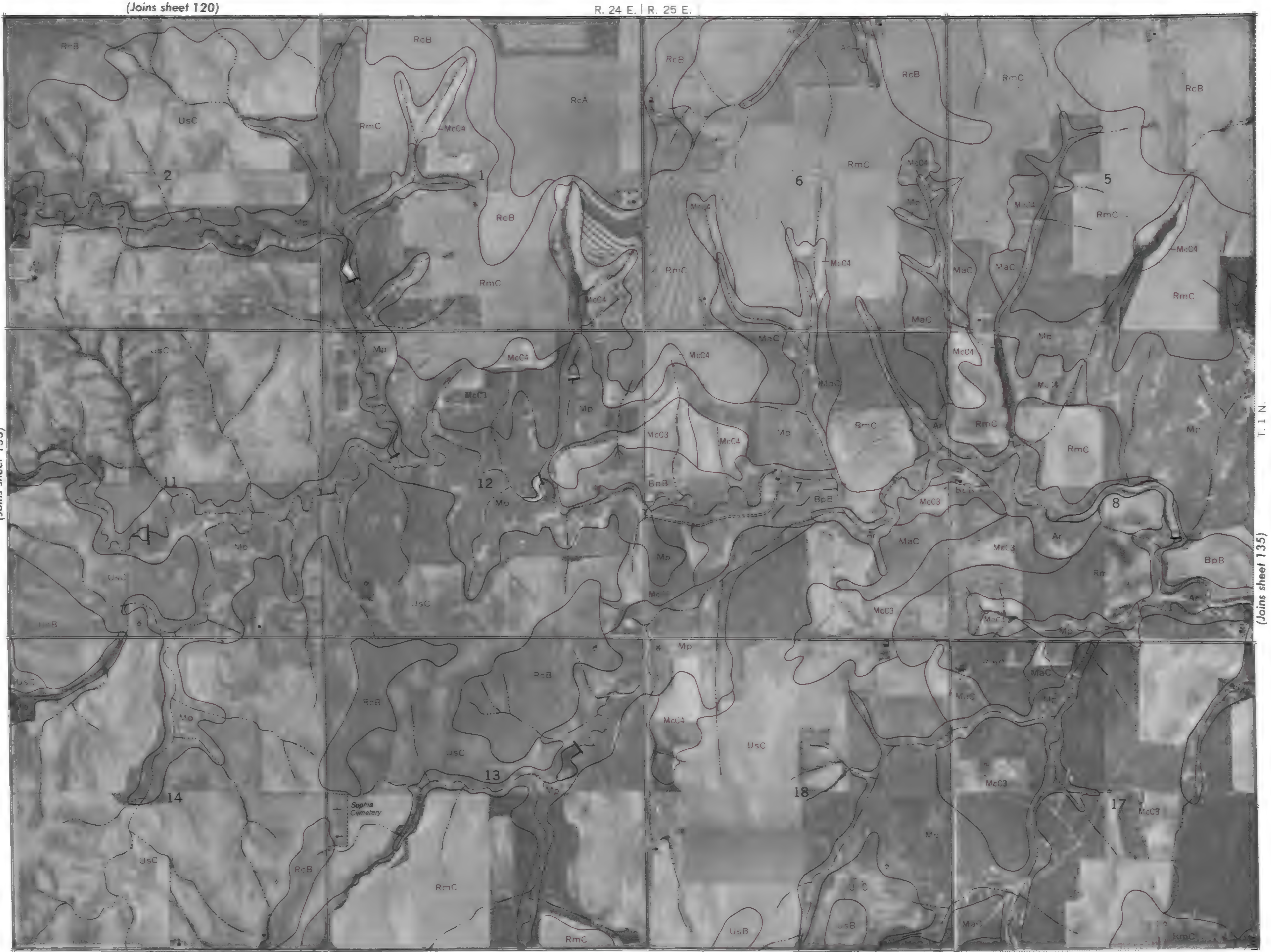
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

134

(Joins sheet 120)

R. 24 E. | R. 25 E.

(Joins sheet 133)



T. 1 N.

(Joins sheet 135)

(Joins sheet 147)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite.

136
(Joins sheet 122)
R. 26 E.
N
(Joins sheet 135)
(Joins sheet 137)
T. 1 N.
(Joins sheet 149)
6
5
4
3
7
8
9
10
18
17
16
15
Scale 1:20 000
0
½
1 Mile
5000 Feet

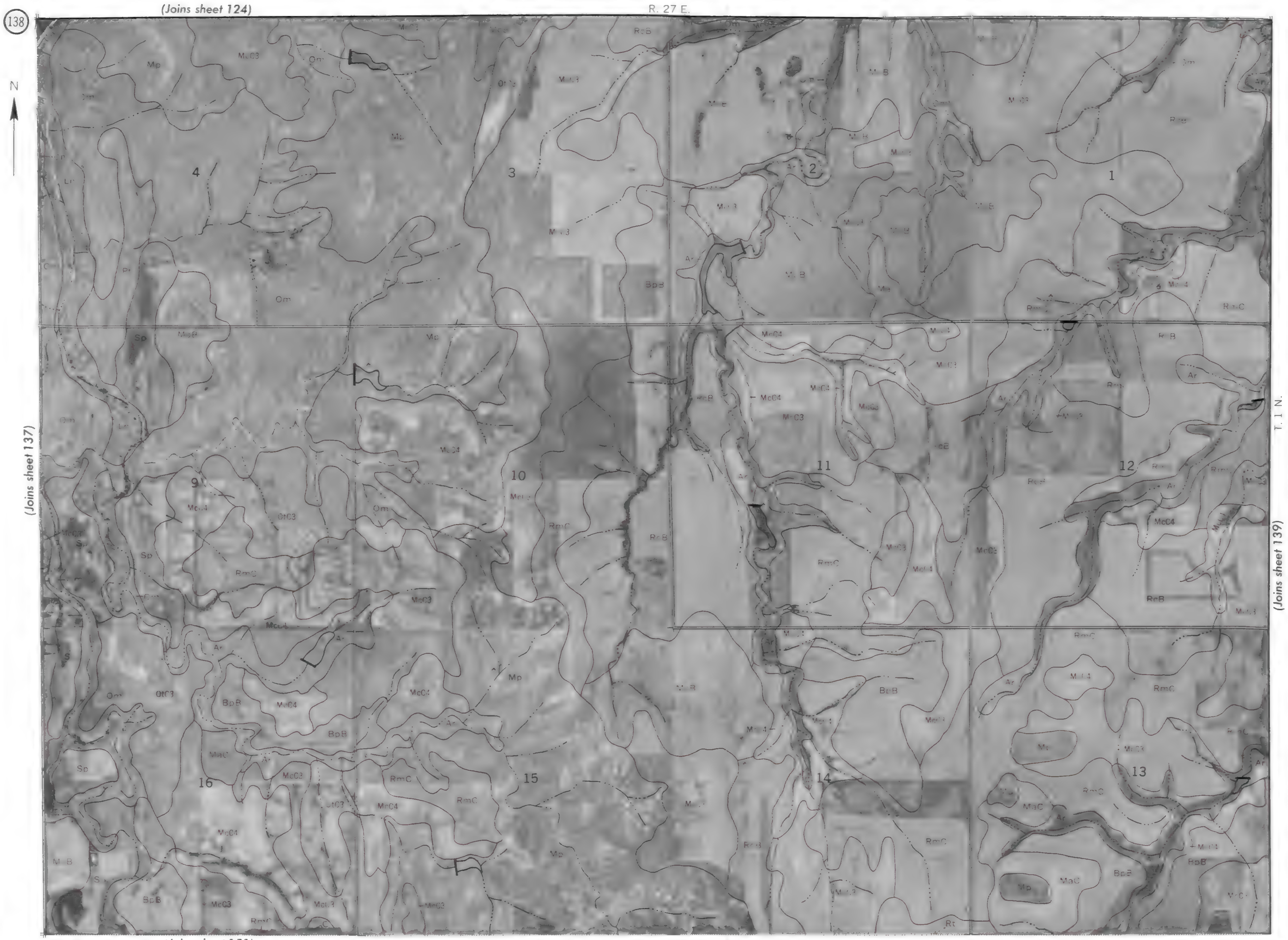
BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 137

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

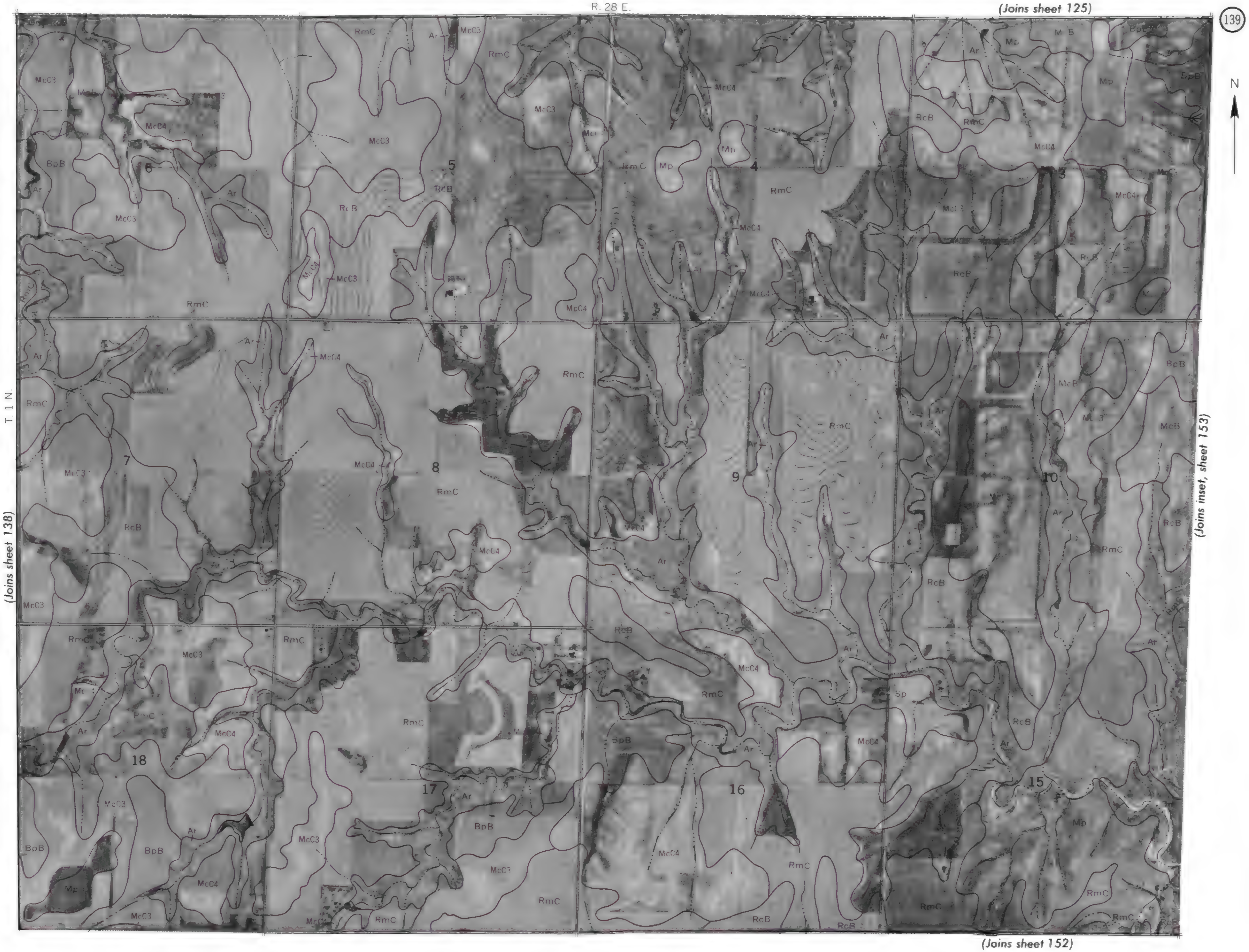
Range, township, and section corners shown on this map are indefinite.

(Joins sheet 124)



(Joins sheet 151)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite.

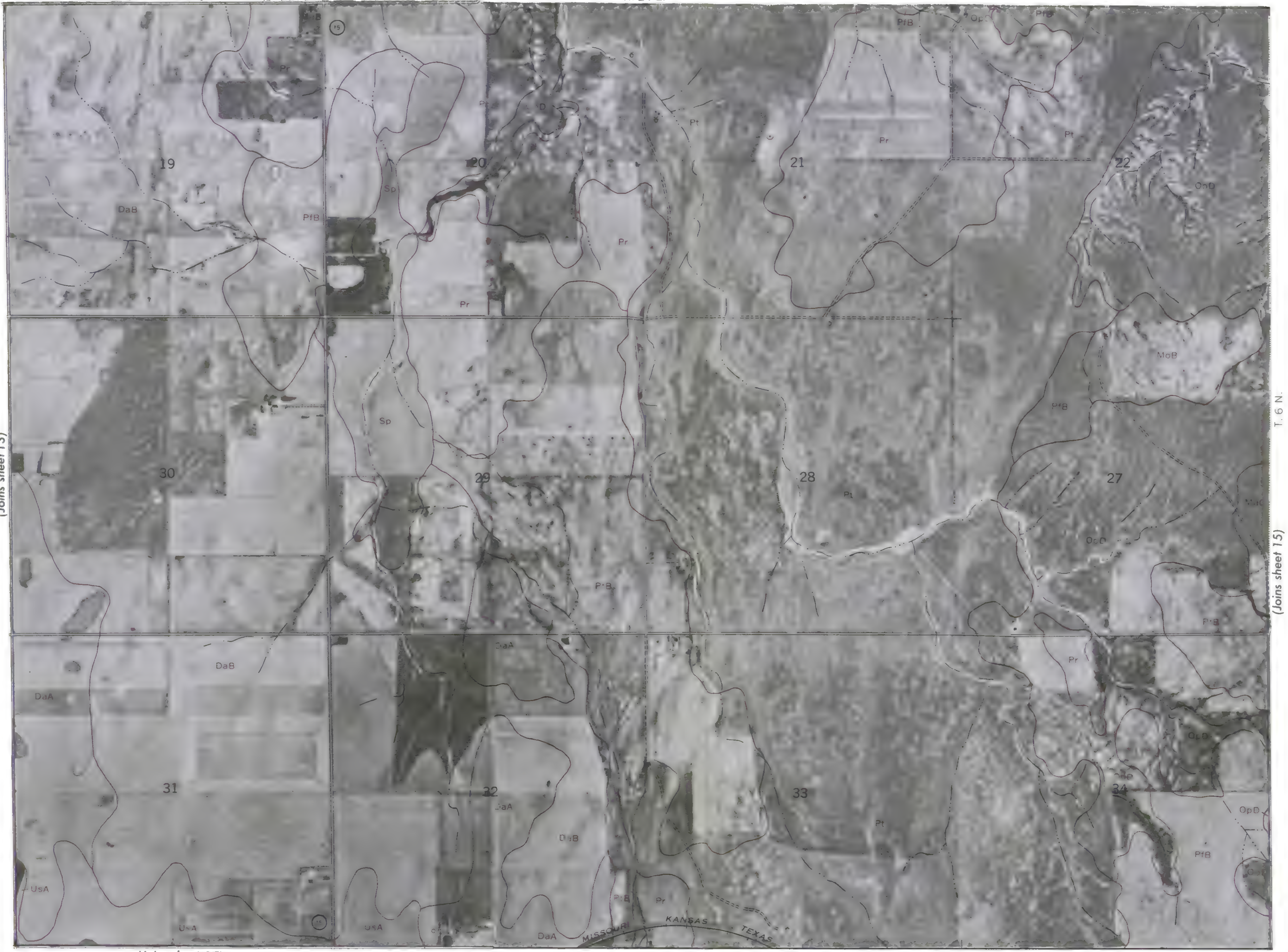
14

(Joins sheet 4)

R. 24 E.

N

(Joins sheet 13)

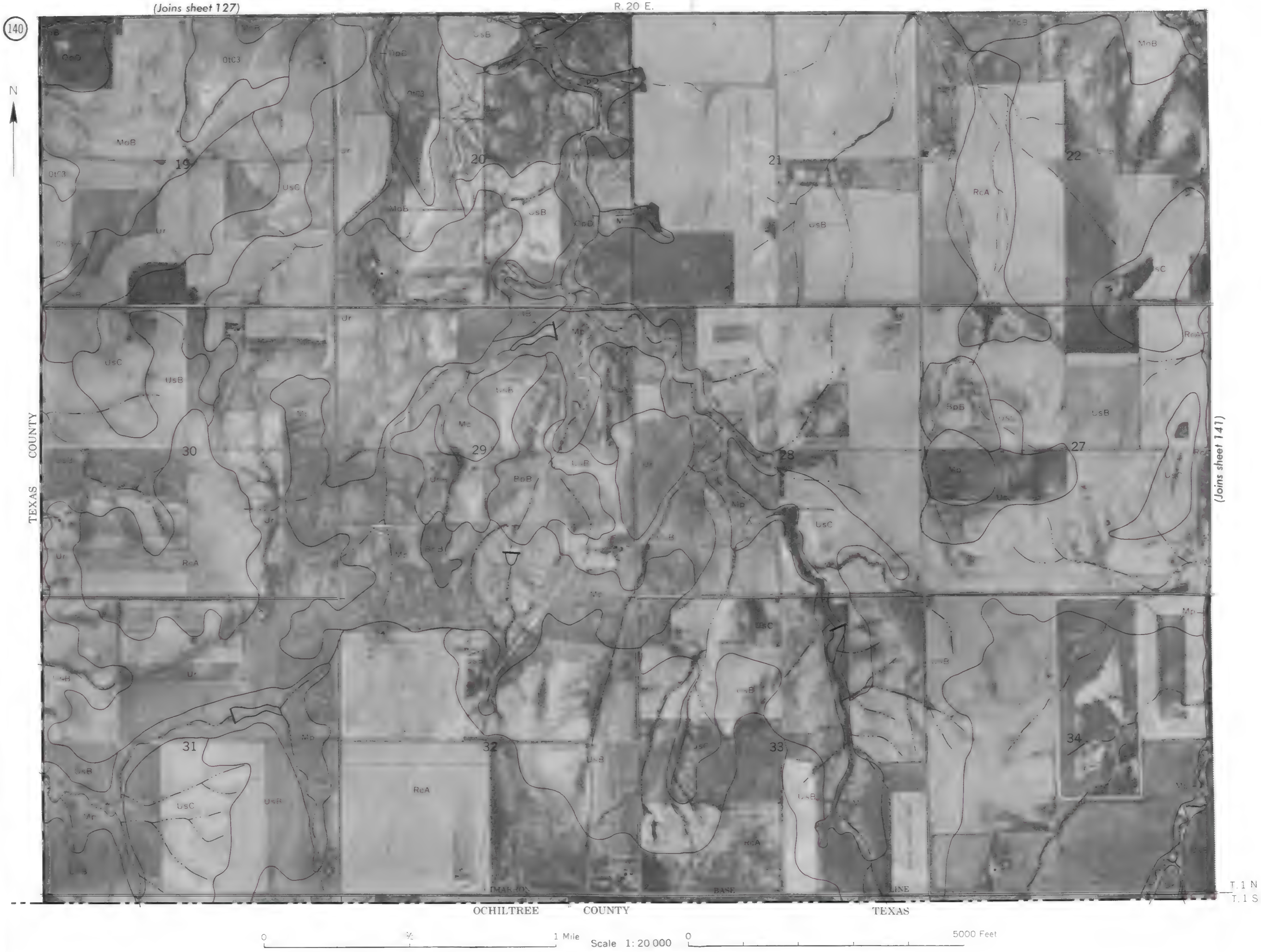


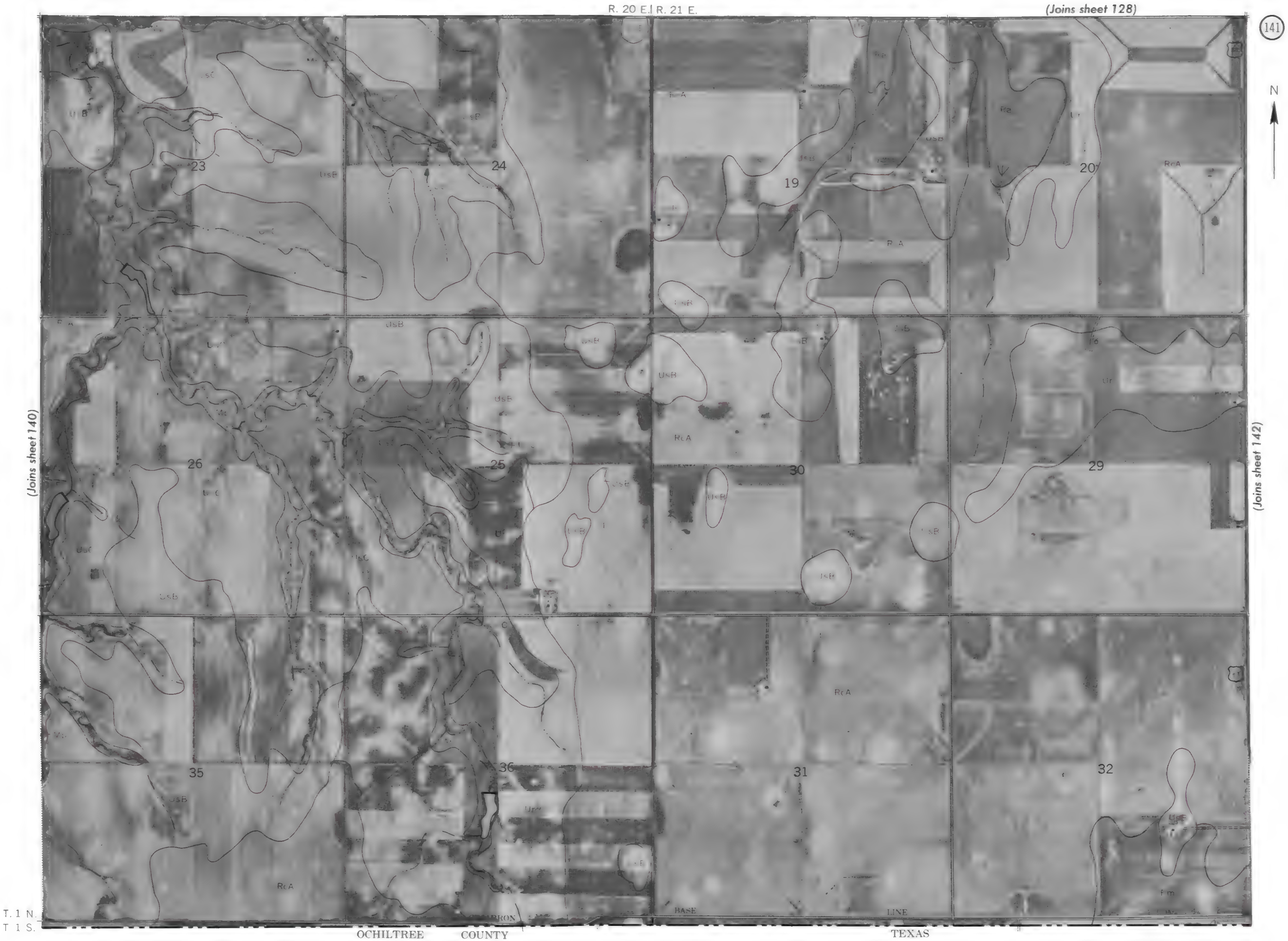
T. 6 N.

(Joins sheet 15)

(Joins sheet 27)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

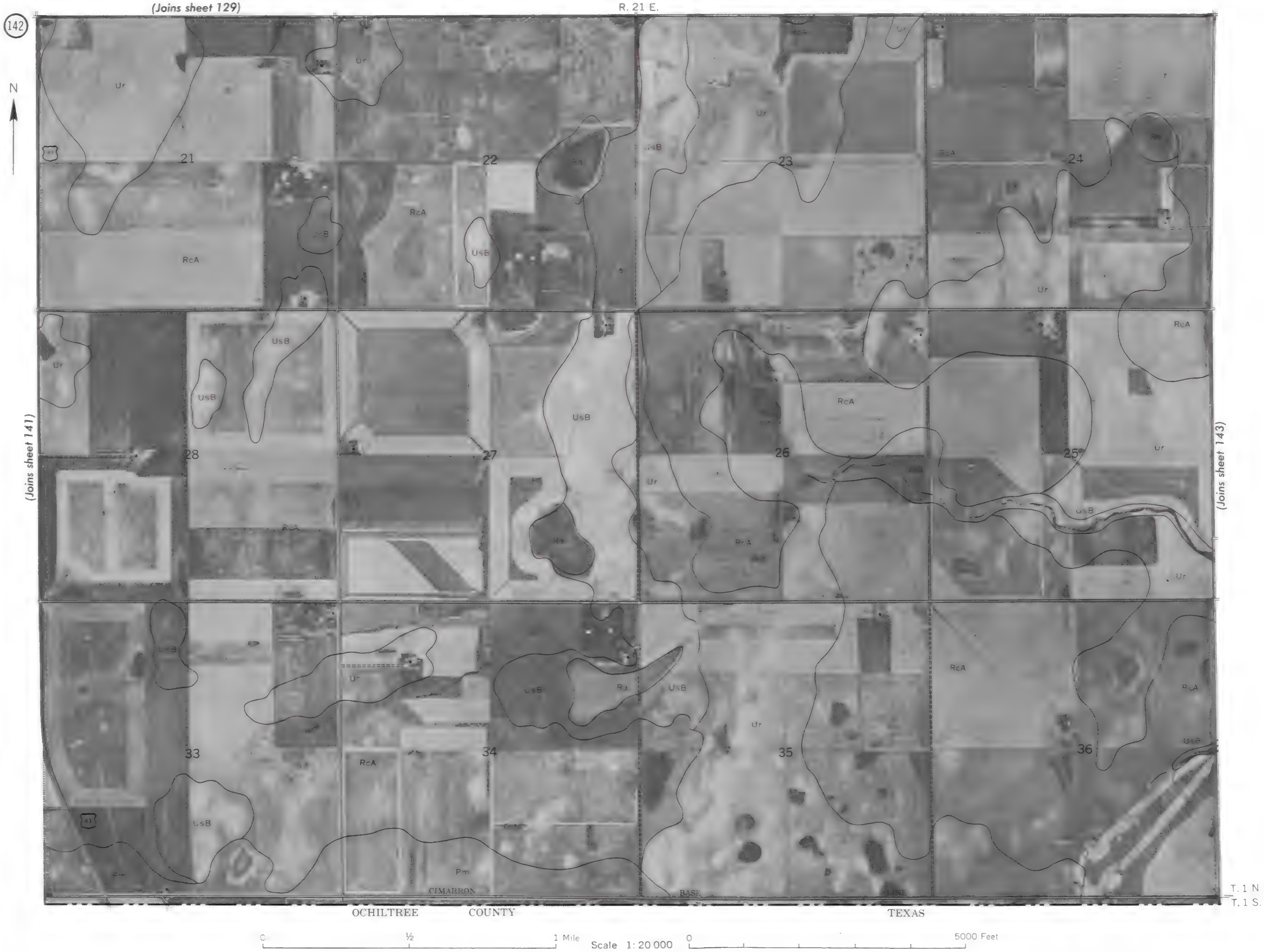

140
(Joins sheet 127)
R. 20 E.
N
(Joins sheet 141)
TEXAS COUNTY
OCHILTREE COUNTY TEXAS
CIMARRON BASE LINE
T. 1 N.
T. 1 S.
19
20
21
22
30
29
28
27
31
32
33
34
MoB
OtC3
UsC
UsB
Ur
RcA
BpB
Mp
UsB
0 ½ 1 Mile
Scale 1:20 000
0 5000 Feet



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photography flown in

Range, township, and section corners shown on this map are indefinite

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


(Joins sheet 129)
R. 21 E.
142
N
(Joins sheet 141)
(Joins sheet 143)
21
22
23
24
28
27
26
25
33
34
35
36
Ur
RcA
UsB
Ra
Pm
CIMARRON
BASE
LINE
OCHILTREE
COUNTY
TEXAS
T. 1 N.
T. 1 S.
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

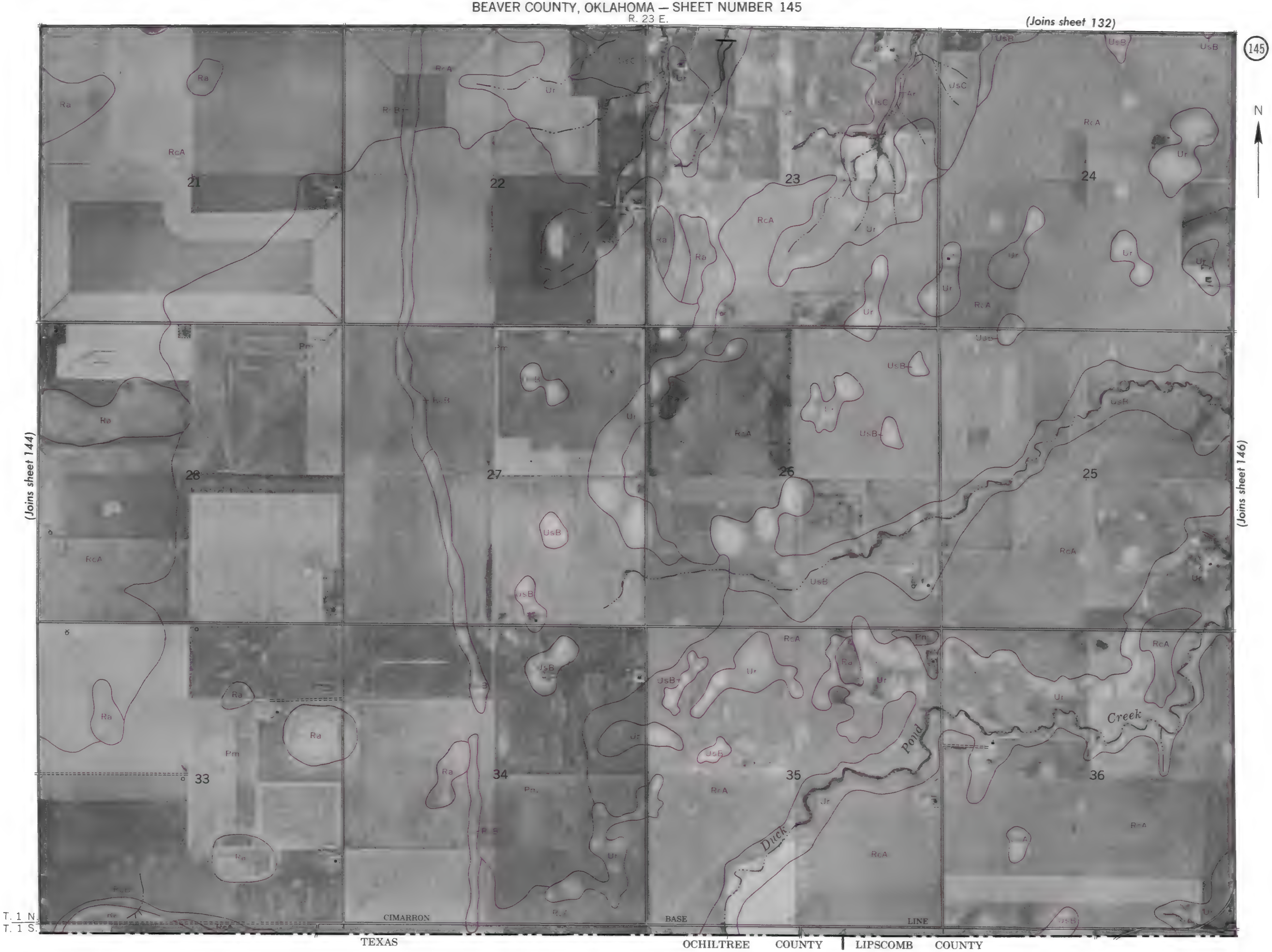
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

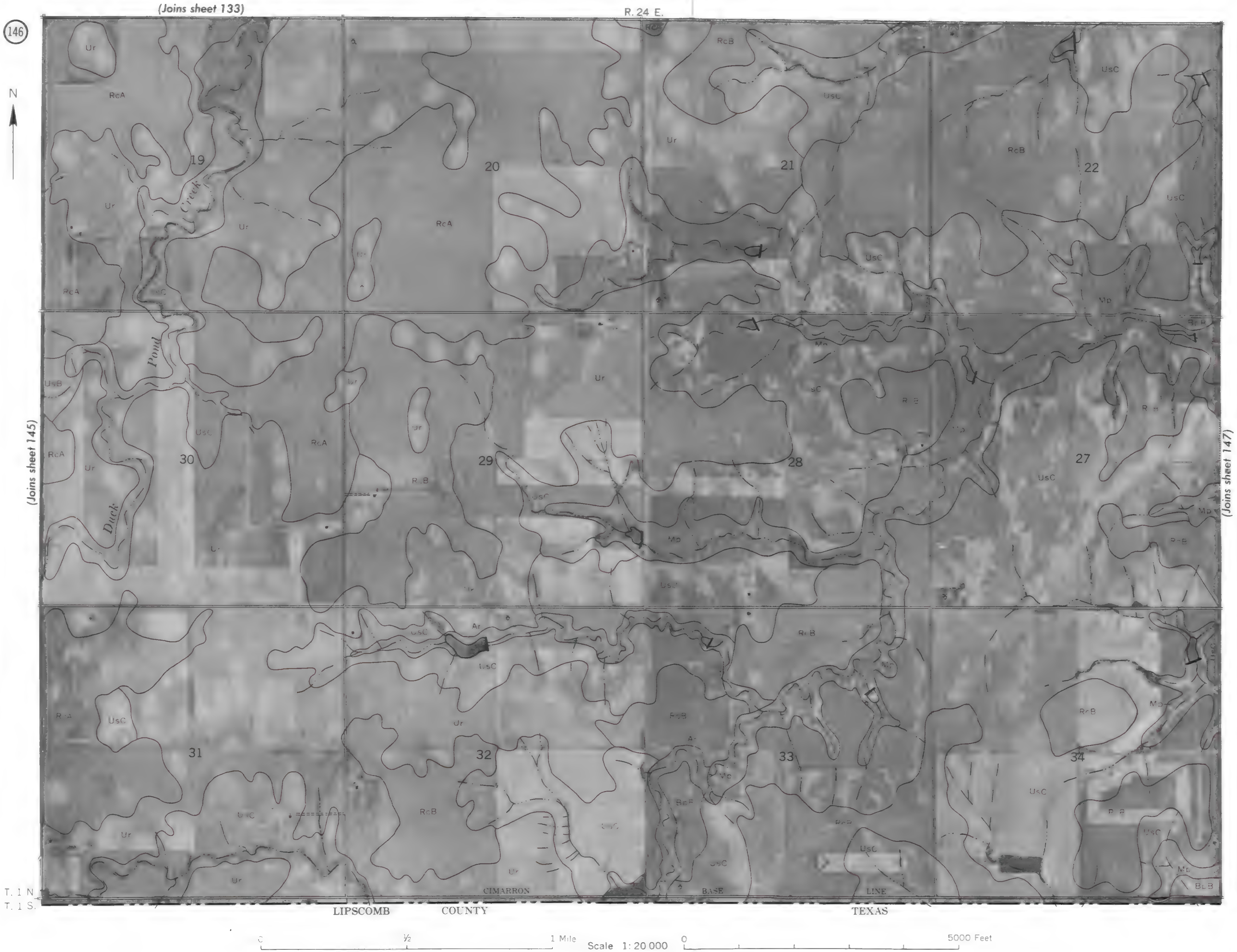
BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 144

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


146
(Joins sheet 133)
R. 24 E.
(Joins sheet 145)
(Joins sheet 147)
N
Ur
RcA
RcB
UsC
Mp
Ar
19
20
21
22
30
29
28
27
31
32
33
34
Duck
Pond
Creek
T. 1 N.
T. 1 S.
CIMARRON
BASE
LINE
LIPSCOMB
COUNTY
TEXAS
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 147

R. 24 E. | R. 25 E.

(Joins sheet 134)

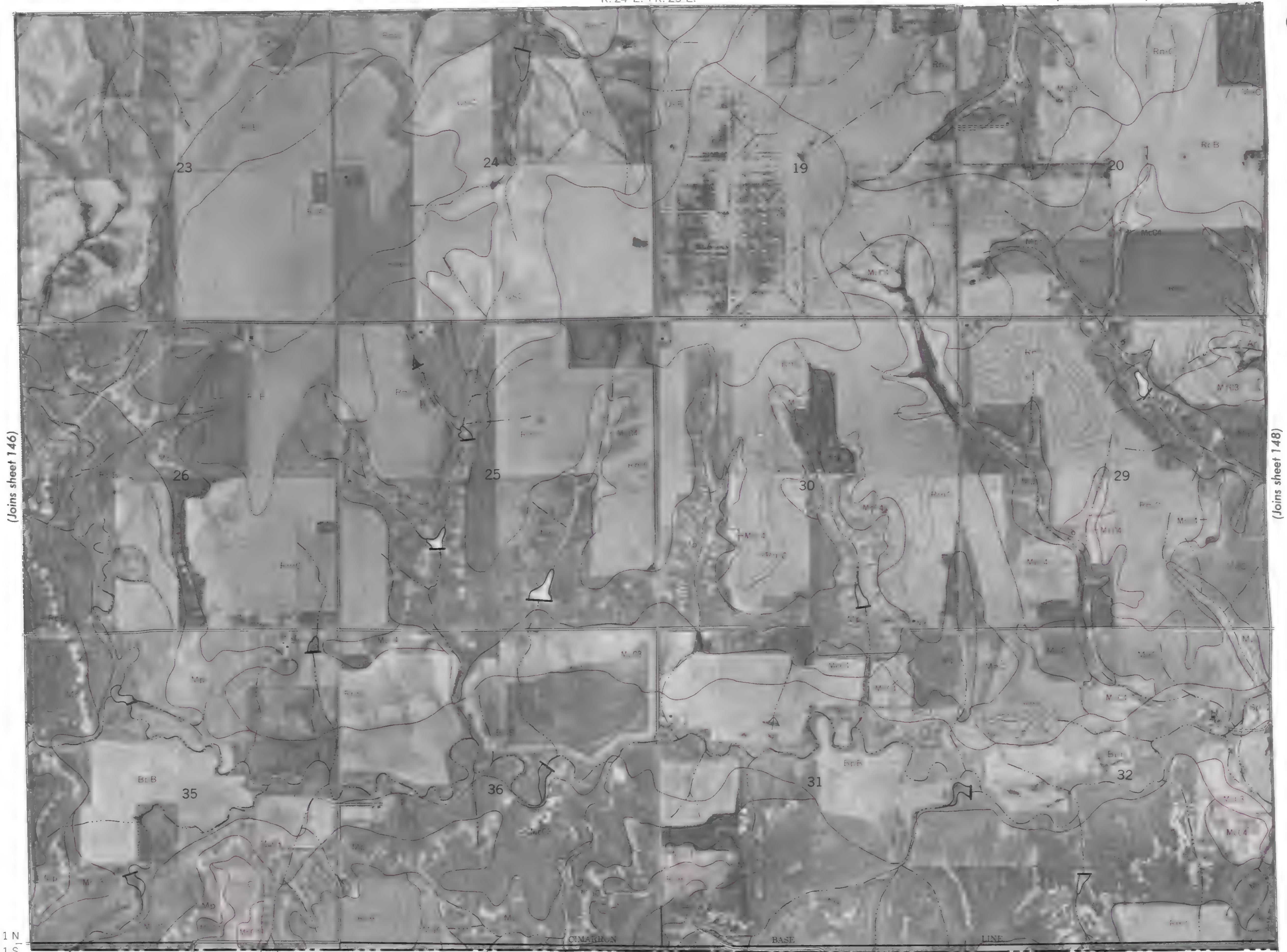
147

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

(Joins sheet 146)

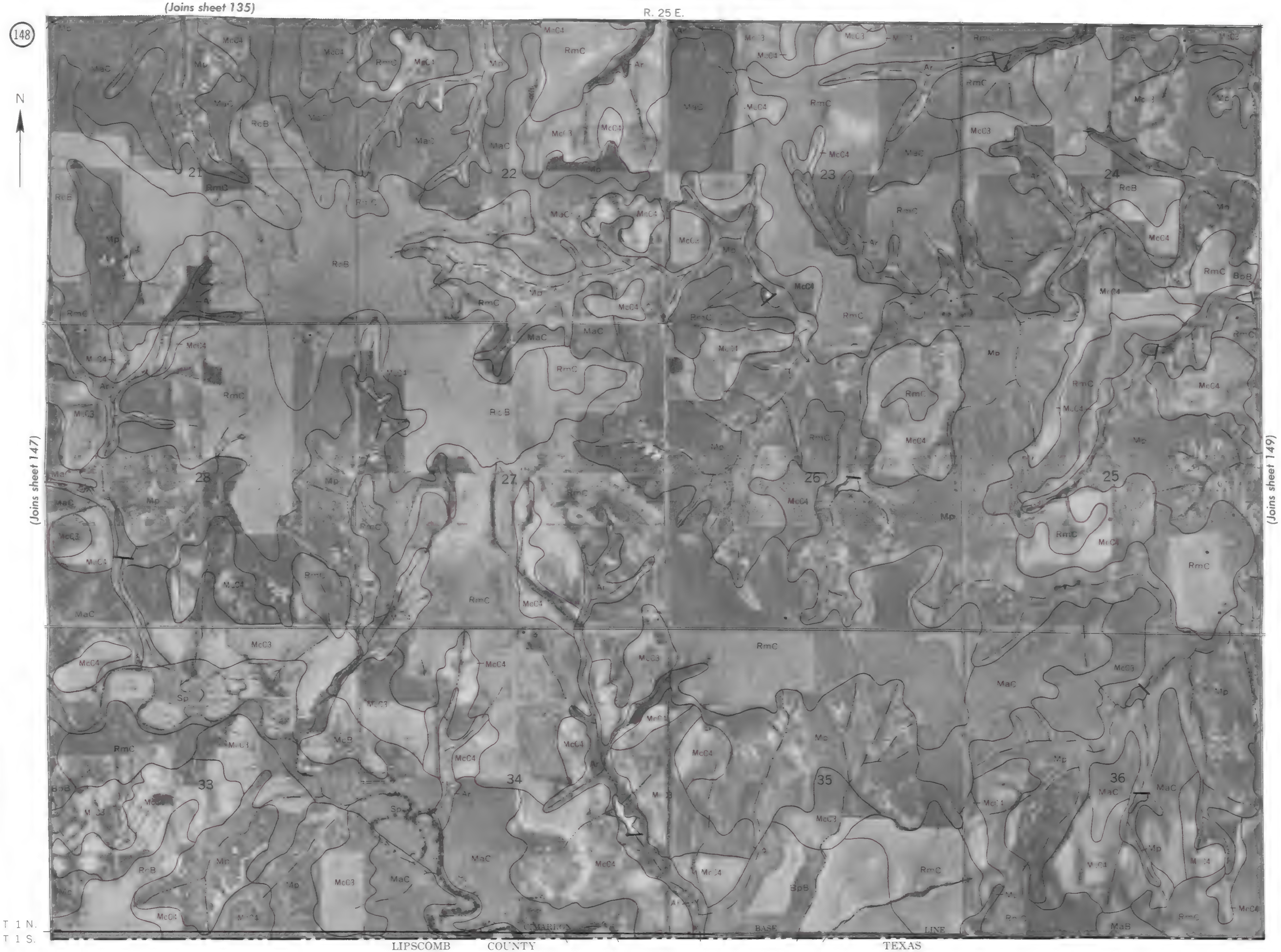
(Joins sheet 148)



T. 1 N.
T. 1 S.

LIPSCOMB COUNTY TEXAS

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

Scale 1: 20 000

0 ½ 1 Mile

0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


150
(Joins sheet 137)
R. 26 E. R. 27 E.
N
(Joins sheet 149)
(Joins sheet 151)
T. 1 N.
23
24
19
20
26
25
30
29
35
36
31
32
CIMARRON
LIPSCOMB
COUNTY
TEXAS
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

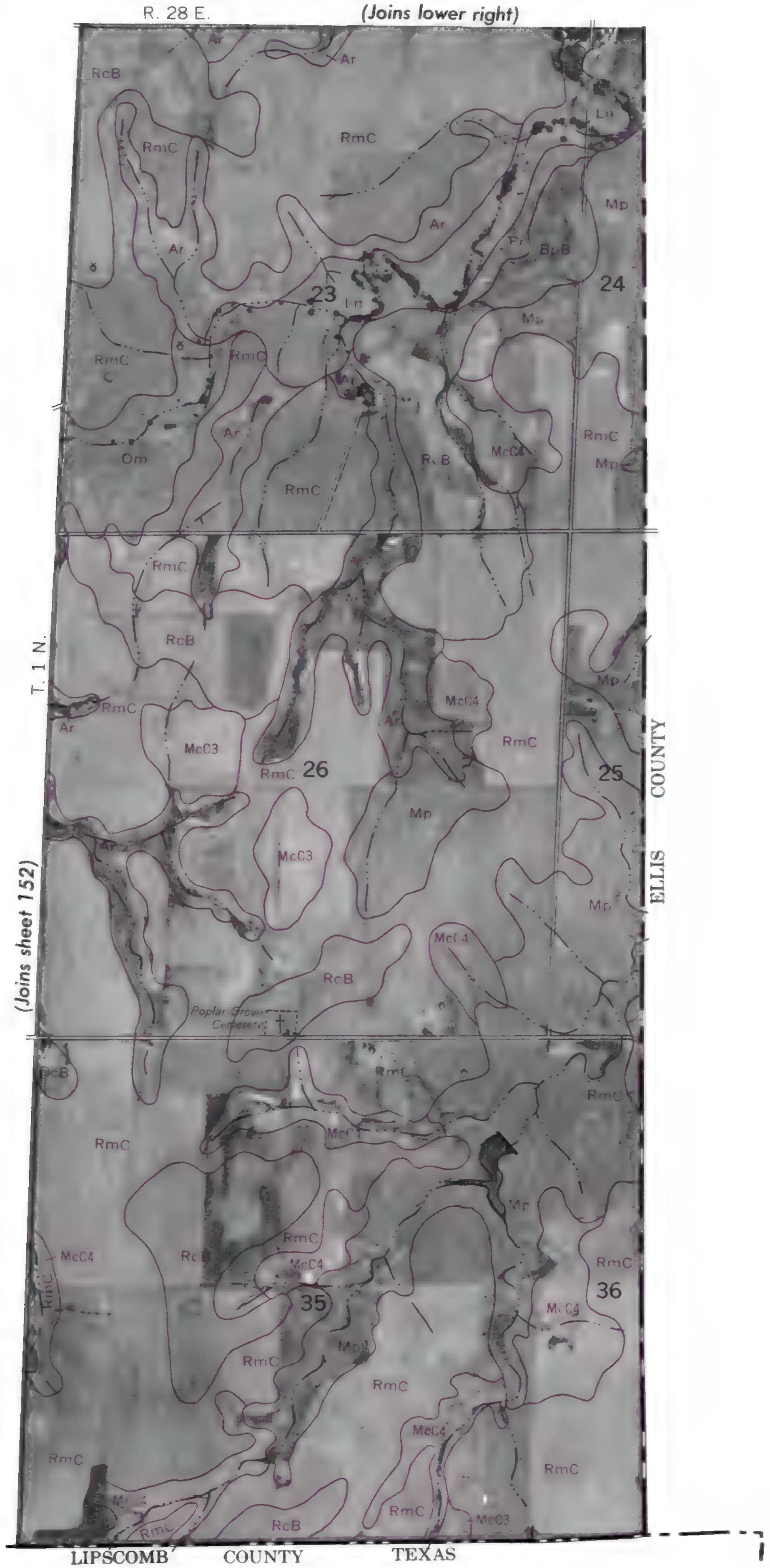
Range, township, and section corners shown on this map are indefinite.

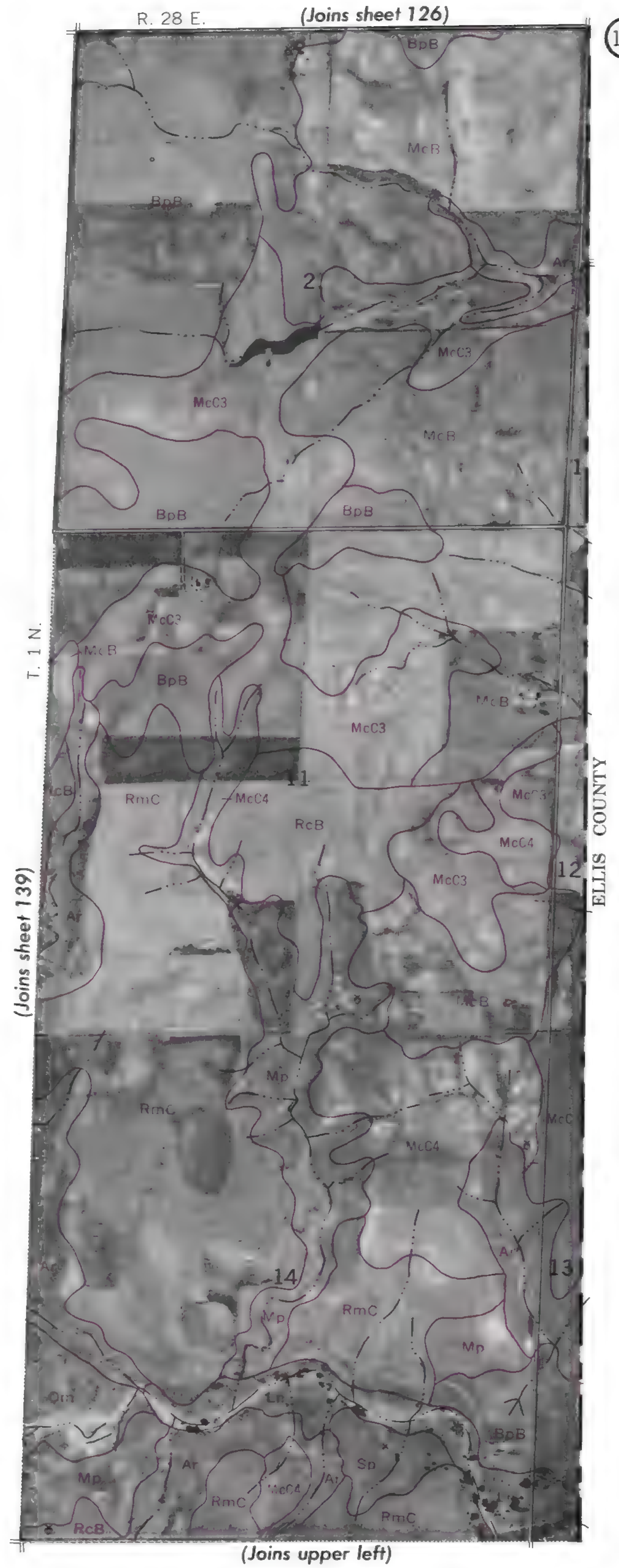
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.



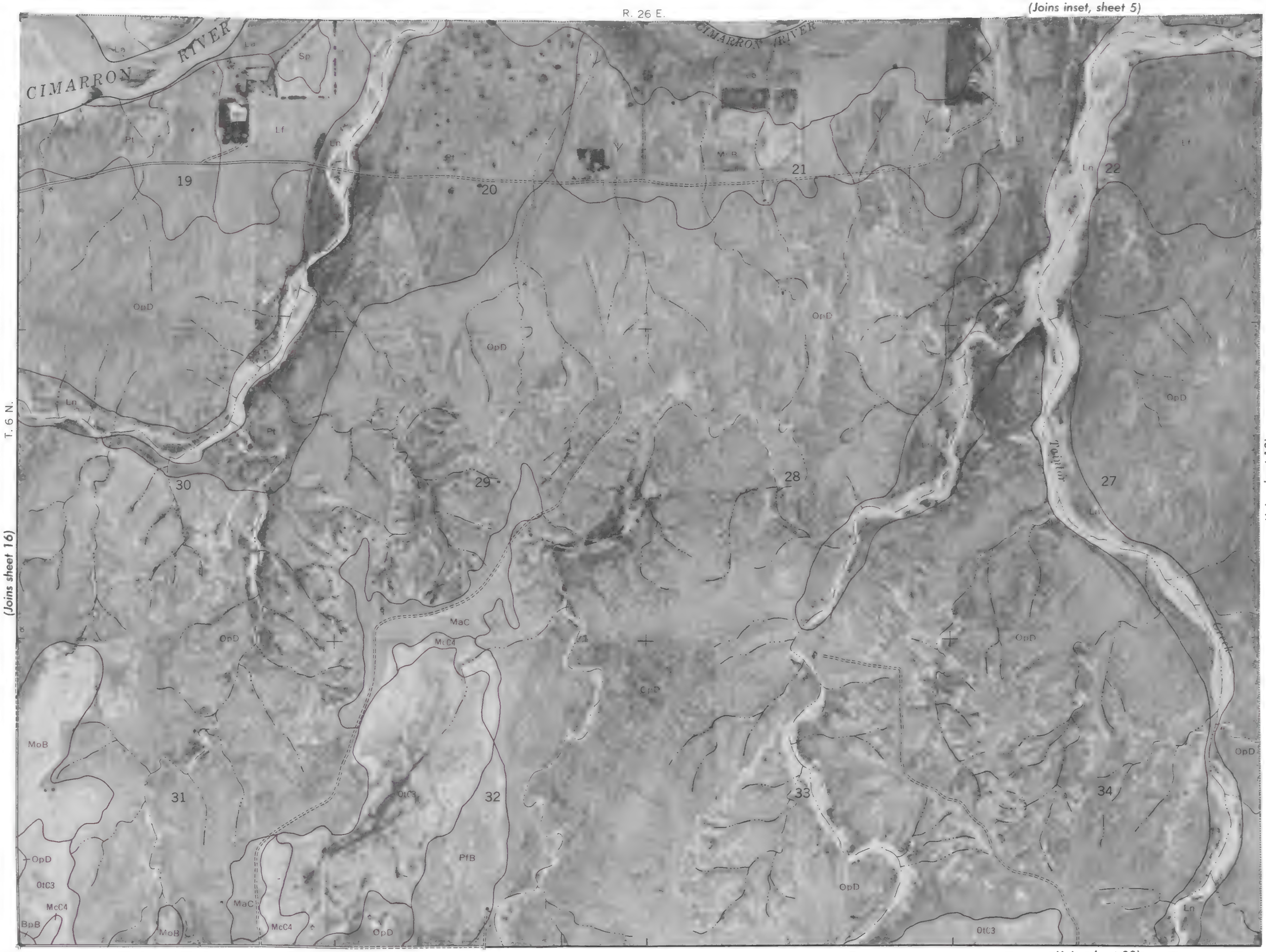


0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

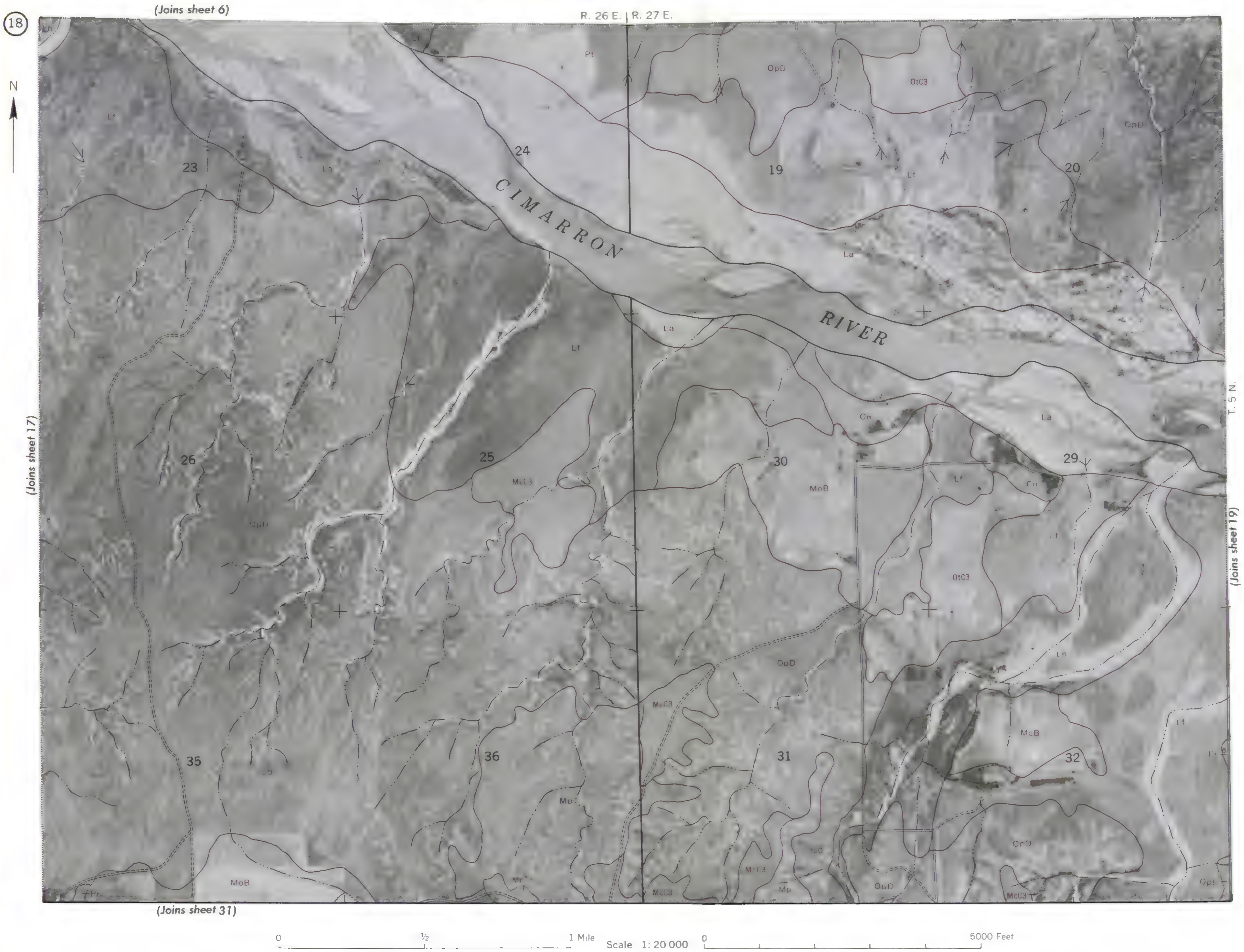
BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 16

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.



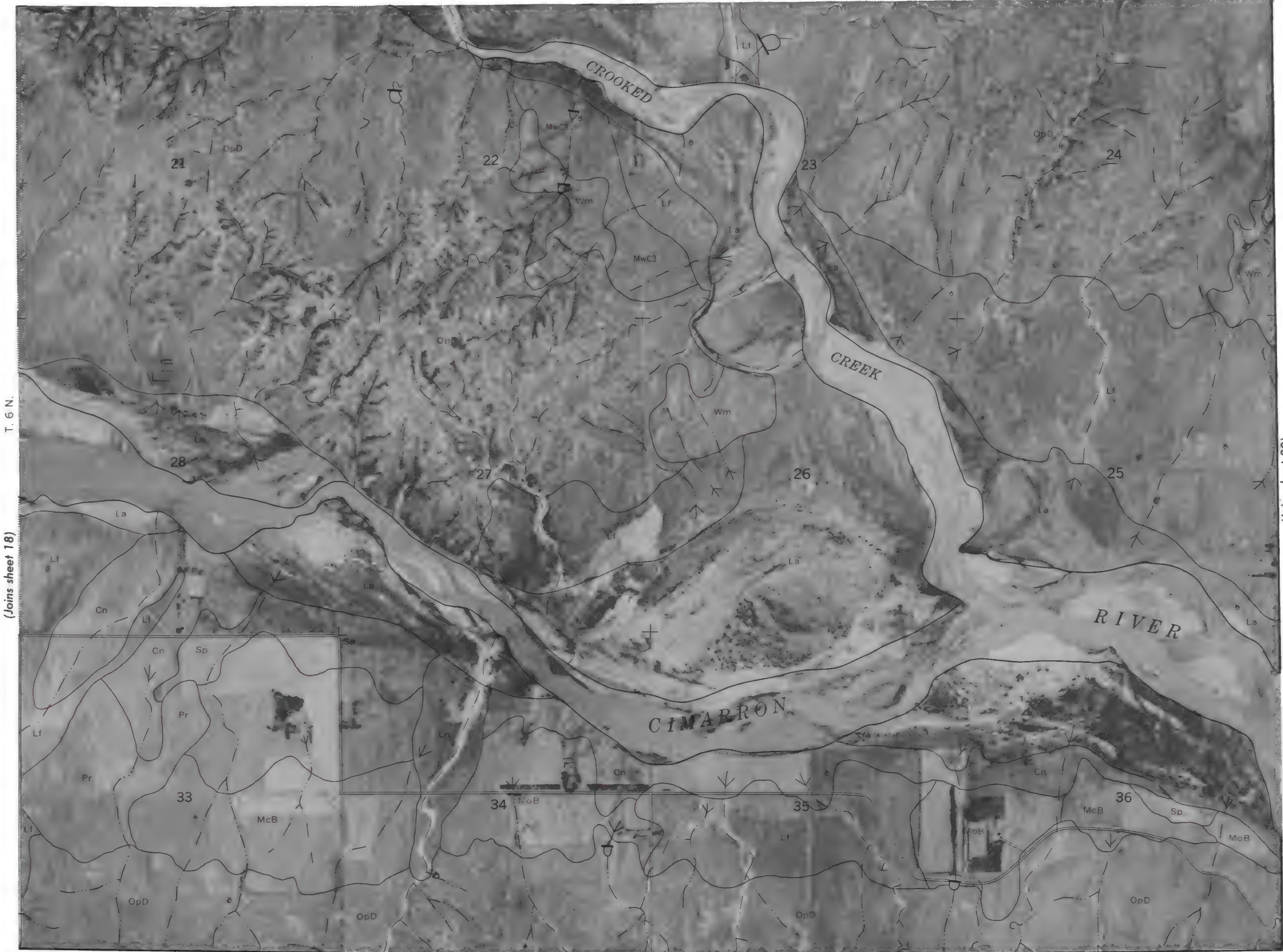
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


18
(Joins sheet 6)
R. 26 E. | R. 27 E.
N
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 31)
T. 5 N.
CIMARRON
RIVER
23
24
19
20
26
25
30
29
35
36
31
32
Lf
La
Pt
OpD
OtC3
Cn
McC3
MoB
McB
Ln
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

R. 27 E.

(Joins inset, sheet 6)

19



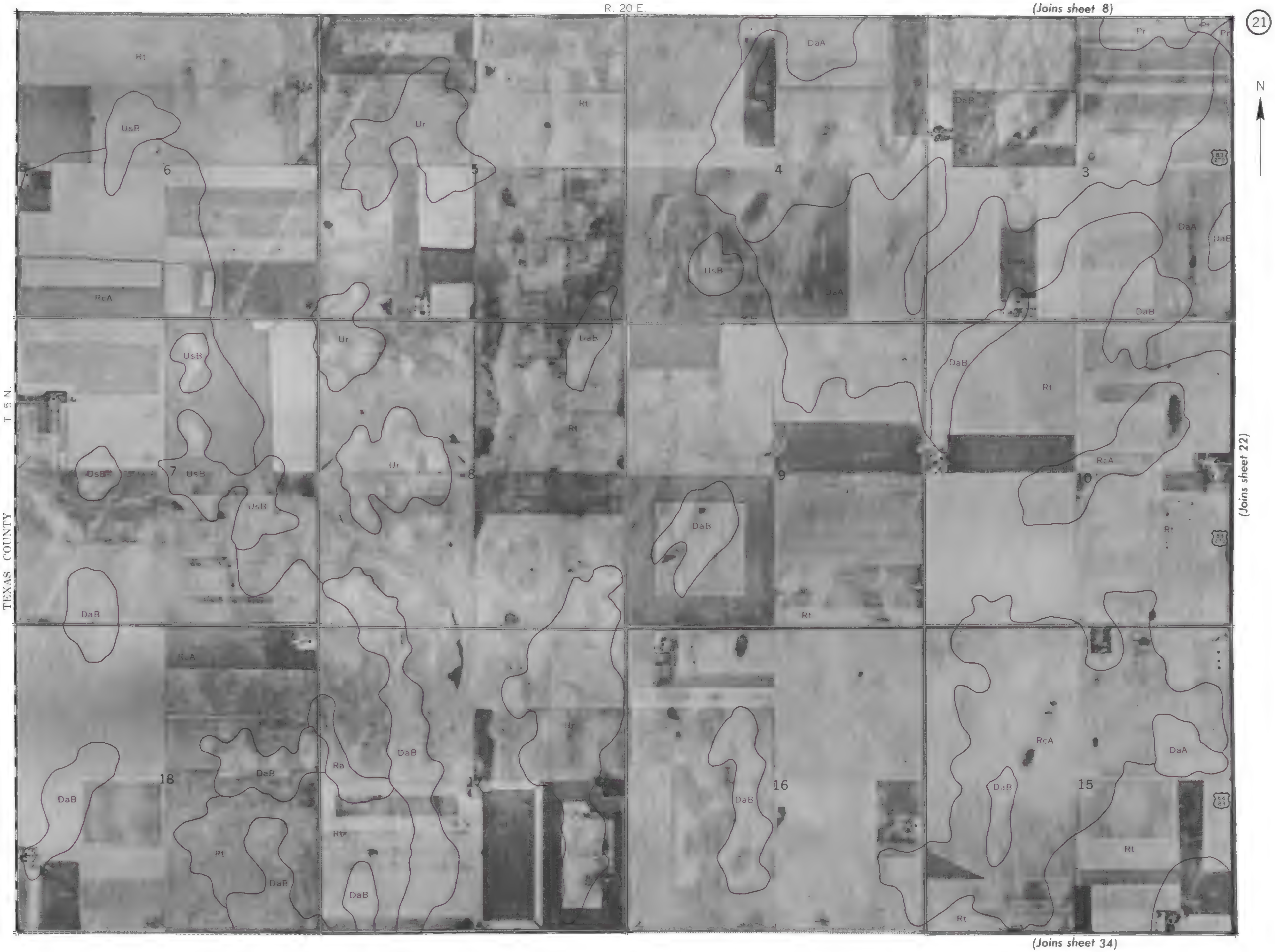
(Joins sheet 32)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

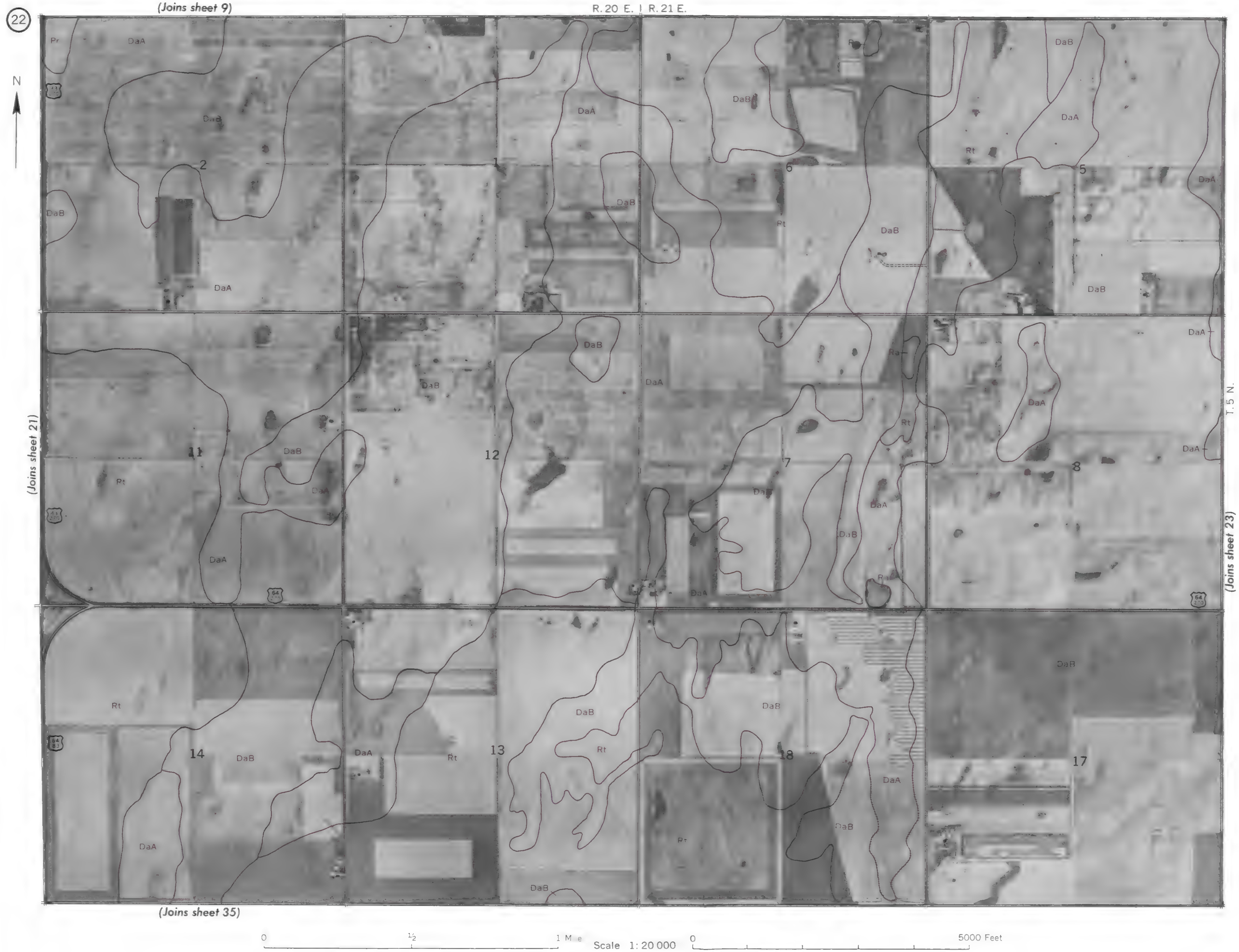
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

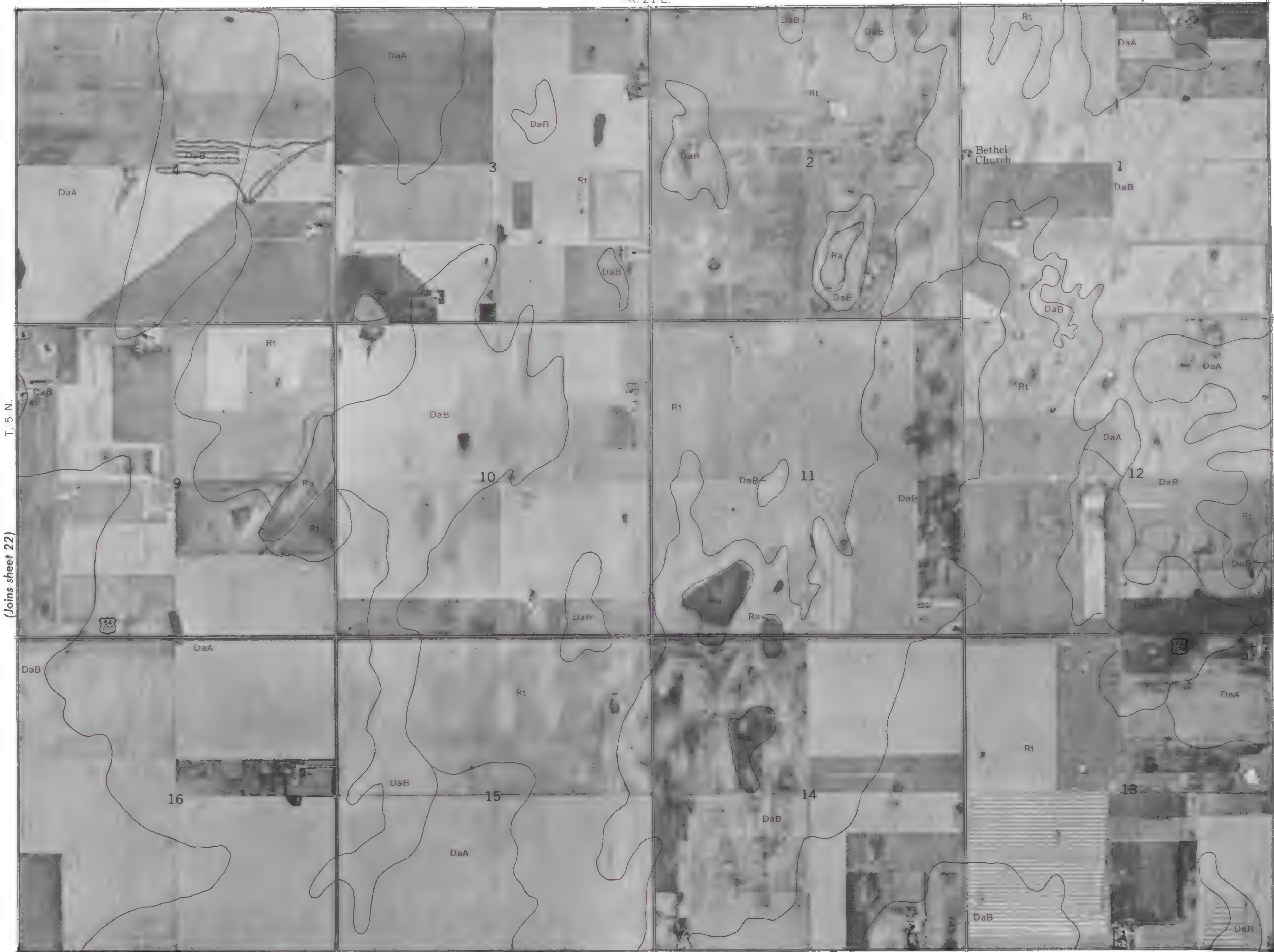
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


22
(Joins sheet 9)
R. 20 E. | R. 21 E.
N
(Joins sheet 21)
(Joins sheet 23)
T. 5 N.
(Joins sheet 35)
Pr
DaA
DaB
Rt
2
1
6
5
11
12
7
8
14
13
18
17
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

R. 21 E. (Joins sheet 10) 23

T. 5 N. (Joins sheet 22) (Joins sheet 24)

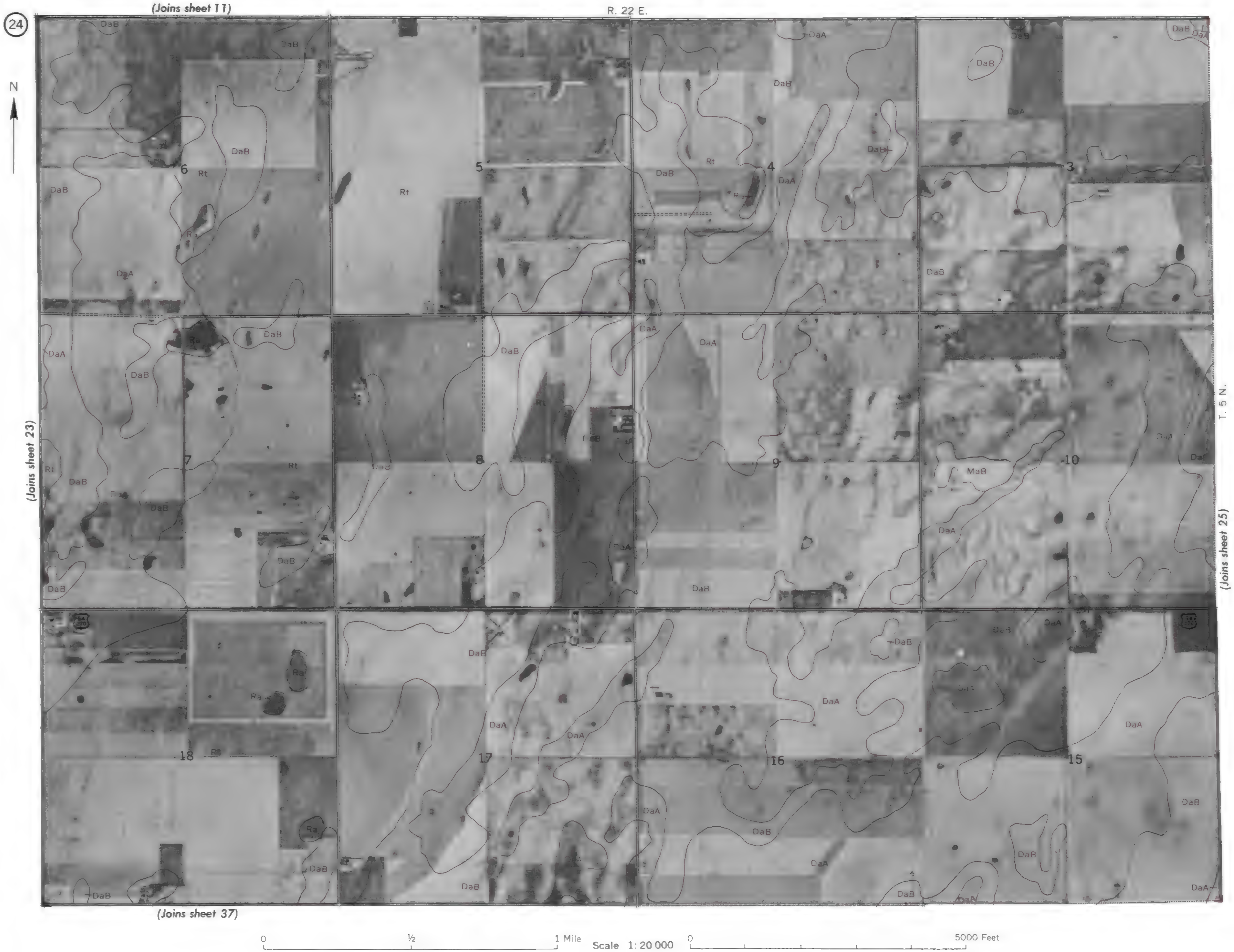


(Joins sheet 36)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


24
(Joins sheet 11)
R. 22 E.
N
(Joins sheet 23)
(Joins sheet 25)
T. 5 N.
(Joins sheet 37)
6
5
4
3
7
8
9
10
18
17
16
15
DaB
DaA
Rt
Ra
MaB
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

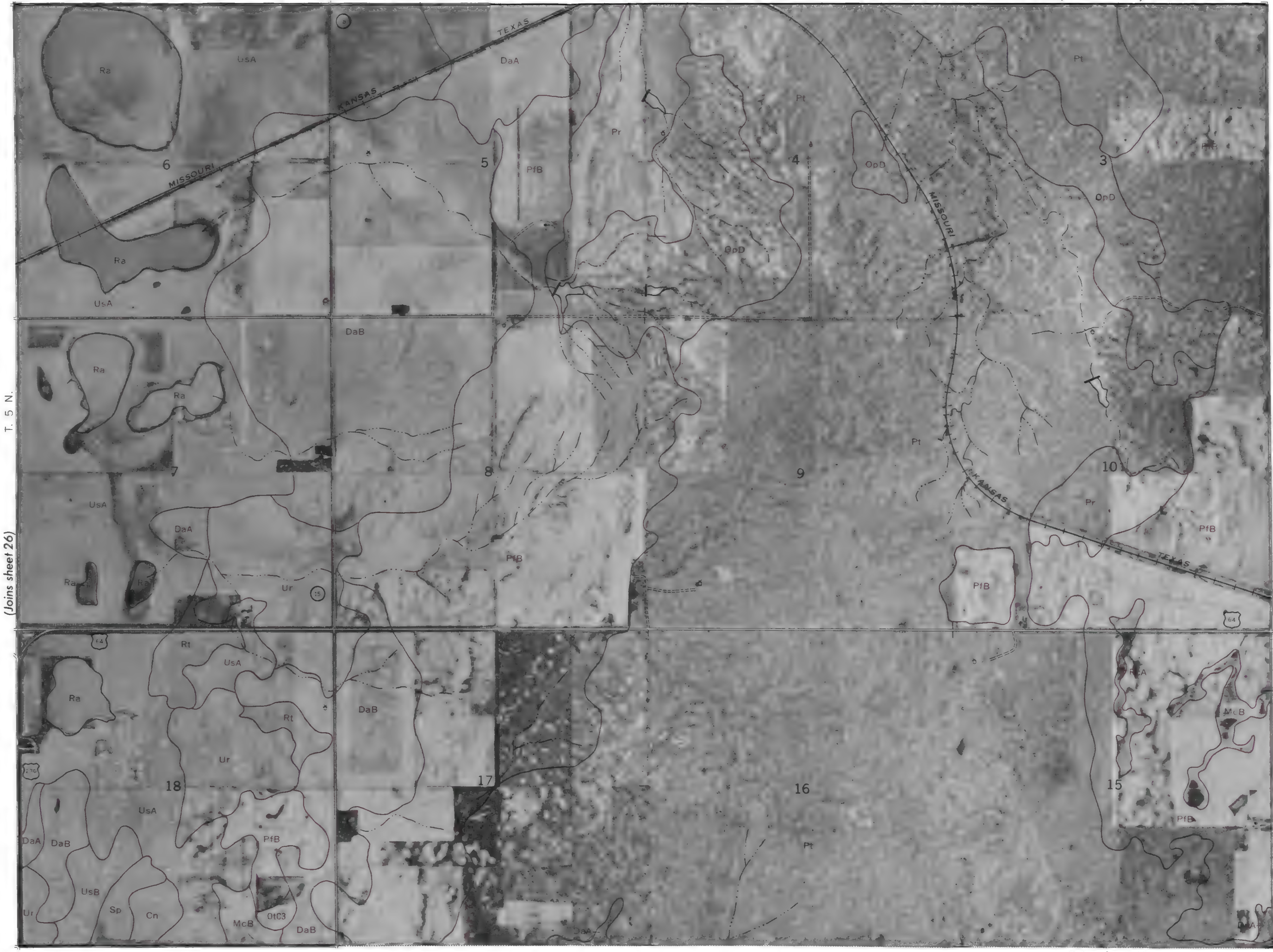
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 25

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


26
(Joins sheet 13)
R. 23 E.
N
(Joins sheet 25)
(Joins sheet 27)
T. 5 N.
(Joins sheet 39)
OpD
DaB
DaA
PfB
Pr
CsA
4
3
2
1
9
10
11
12
16
15
14
13
Forgan
KANSAS
TEXAS
MISSOURI
BEAVER
MEADE
AND
ENGLEWOOD
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

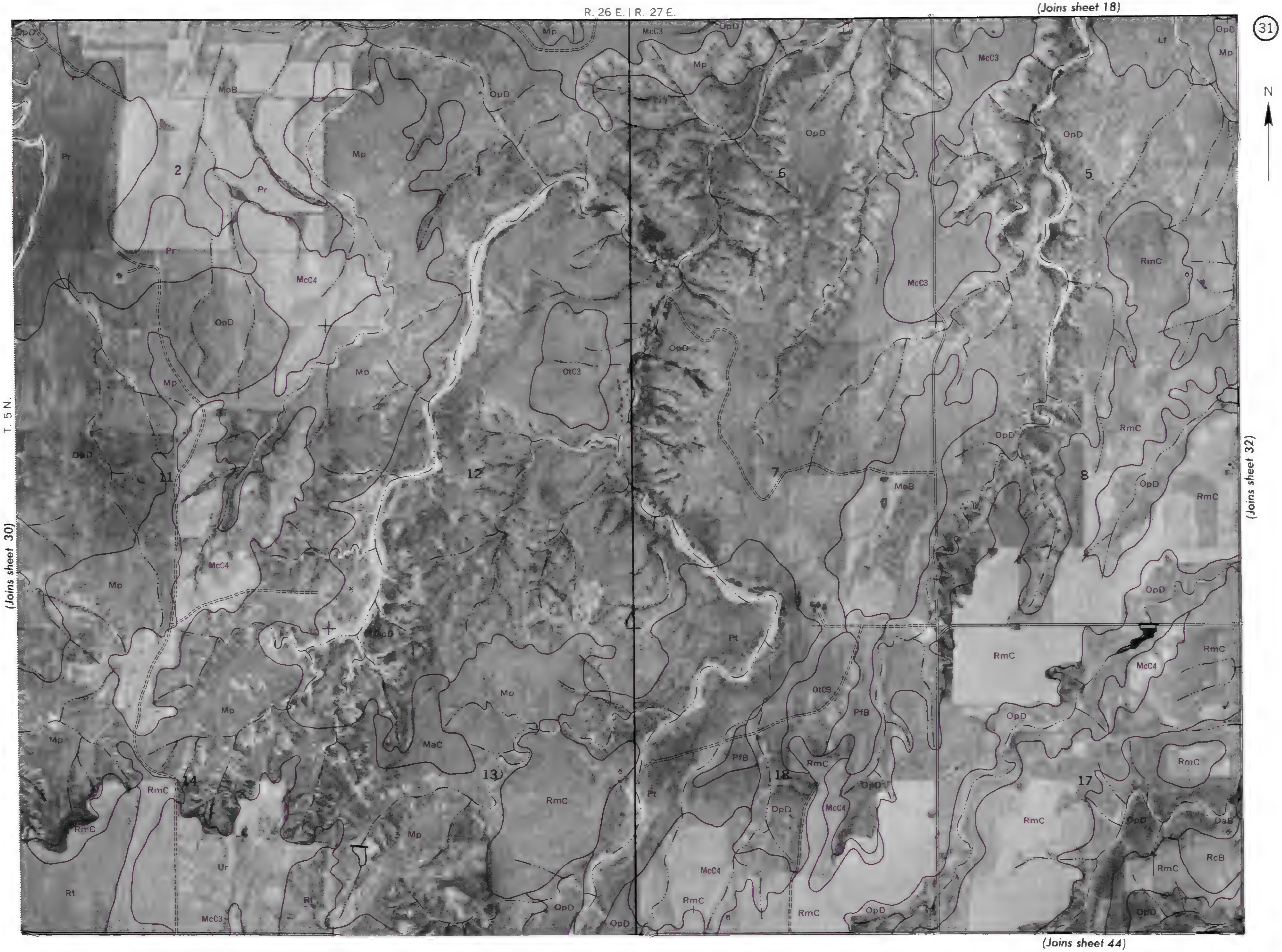

28
(Joins sheet 15)
R. 24 E. | R. 25 E.
N
(Joins sheet 27)
(Joins sheet 29)
T. 5 N.
(Joins sheet 41)
1
2
5
6
7
8
11
12
13
14
17
18
PfB
DaB
KANSAS
TEXAS
Mocane
Scale 1: 20 000
0
1 Mile
5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

Scale 1:20 000 — ½ — 1 Mi. — 0 — 5000 Feet

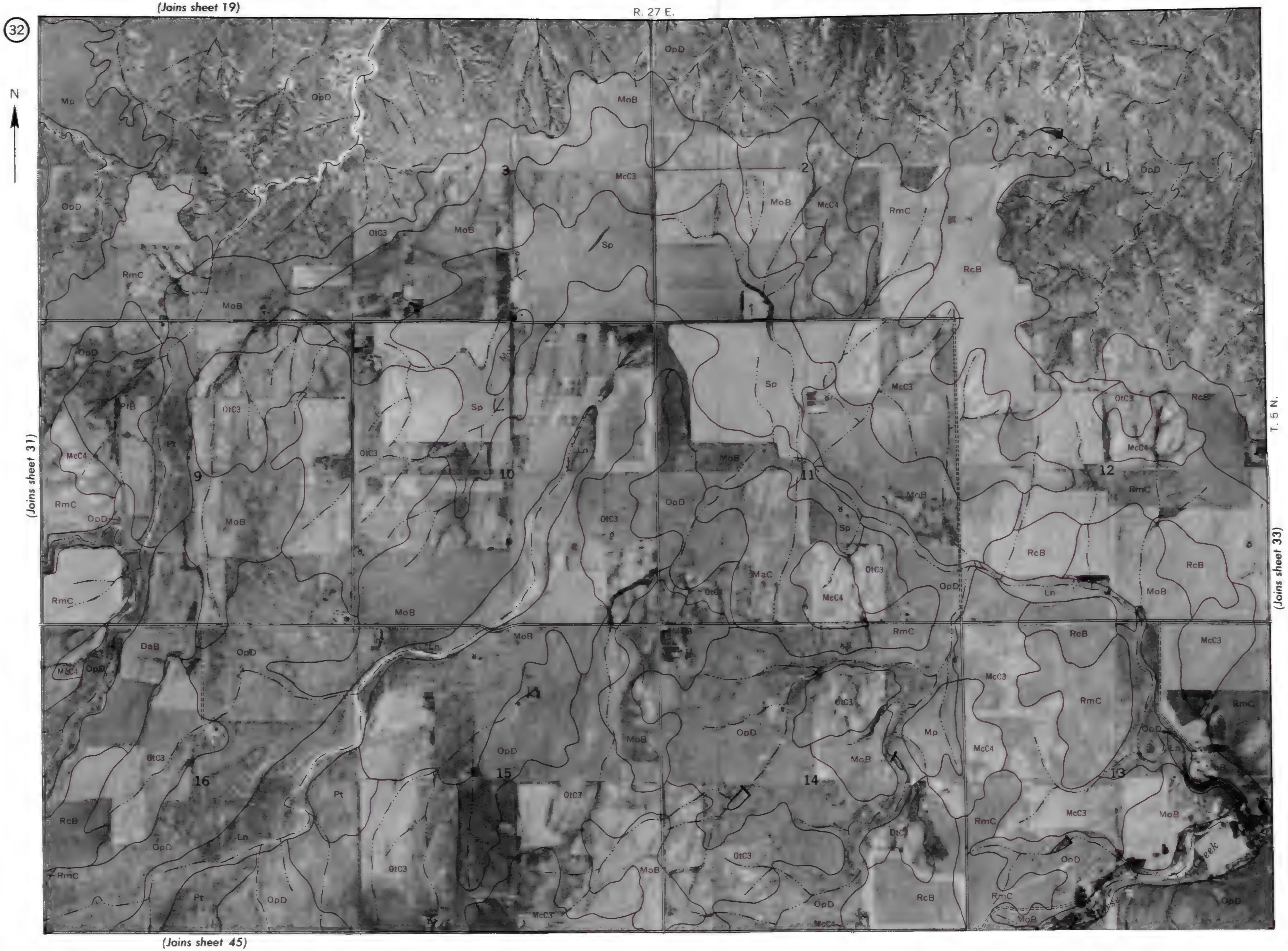

30
(Joins sheet 17)
R. 26 E.
N
(Joins sheet 29)
(Joins sheet 31)
T. 5 N.
(Joins sheet 43)
OtC3
McC4
OpD
MaC
MoB
Mp
MaB
5
4
3
6
7
8
9
10
18
16
15
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

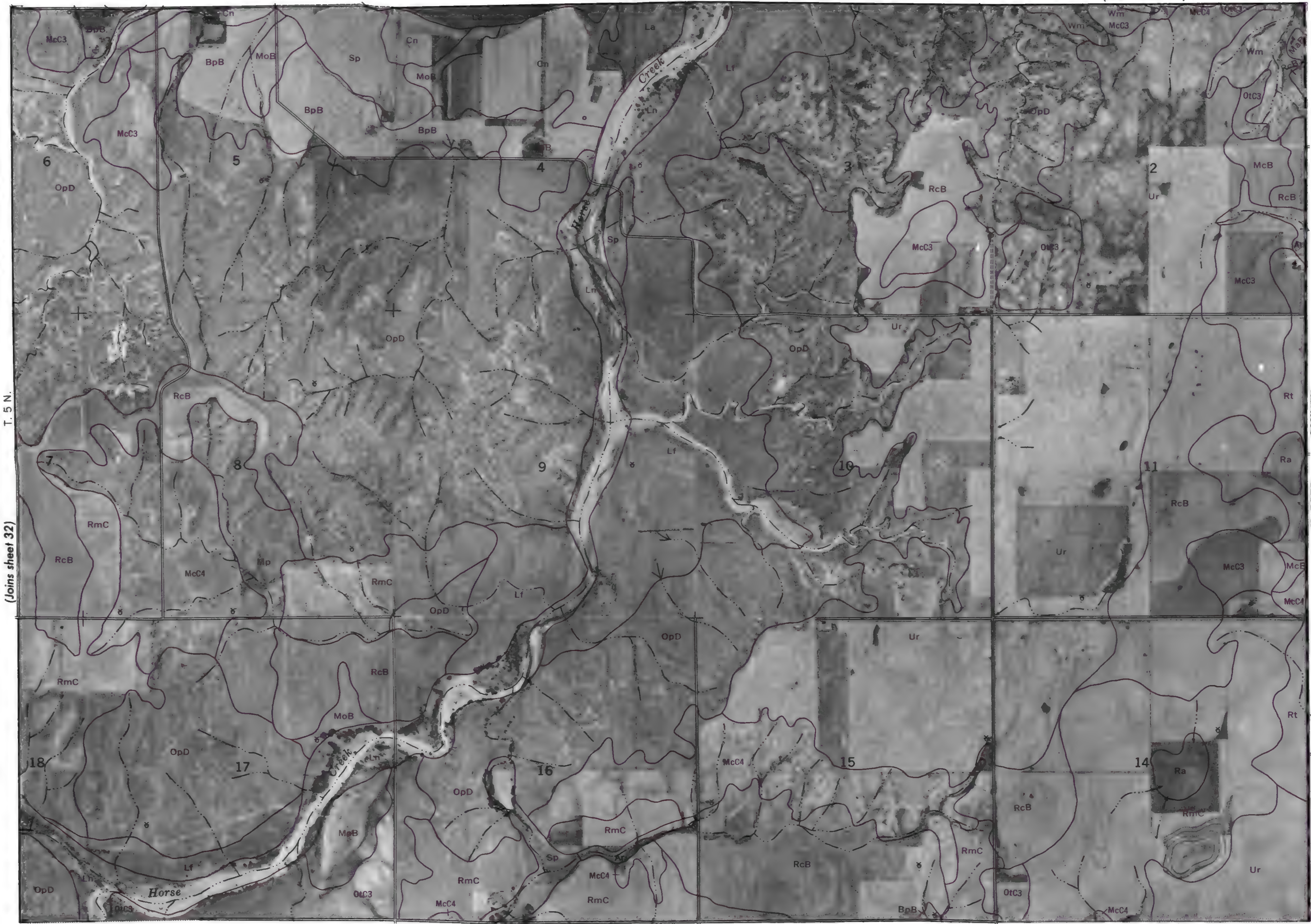


0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 28 E.

(Joins sheet 20)

33



T. 5 N.

(Joins sheet 32)

HARPER COUNTY

(Joins sheet 46)

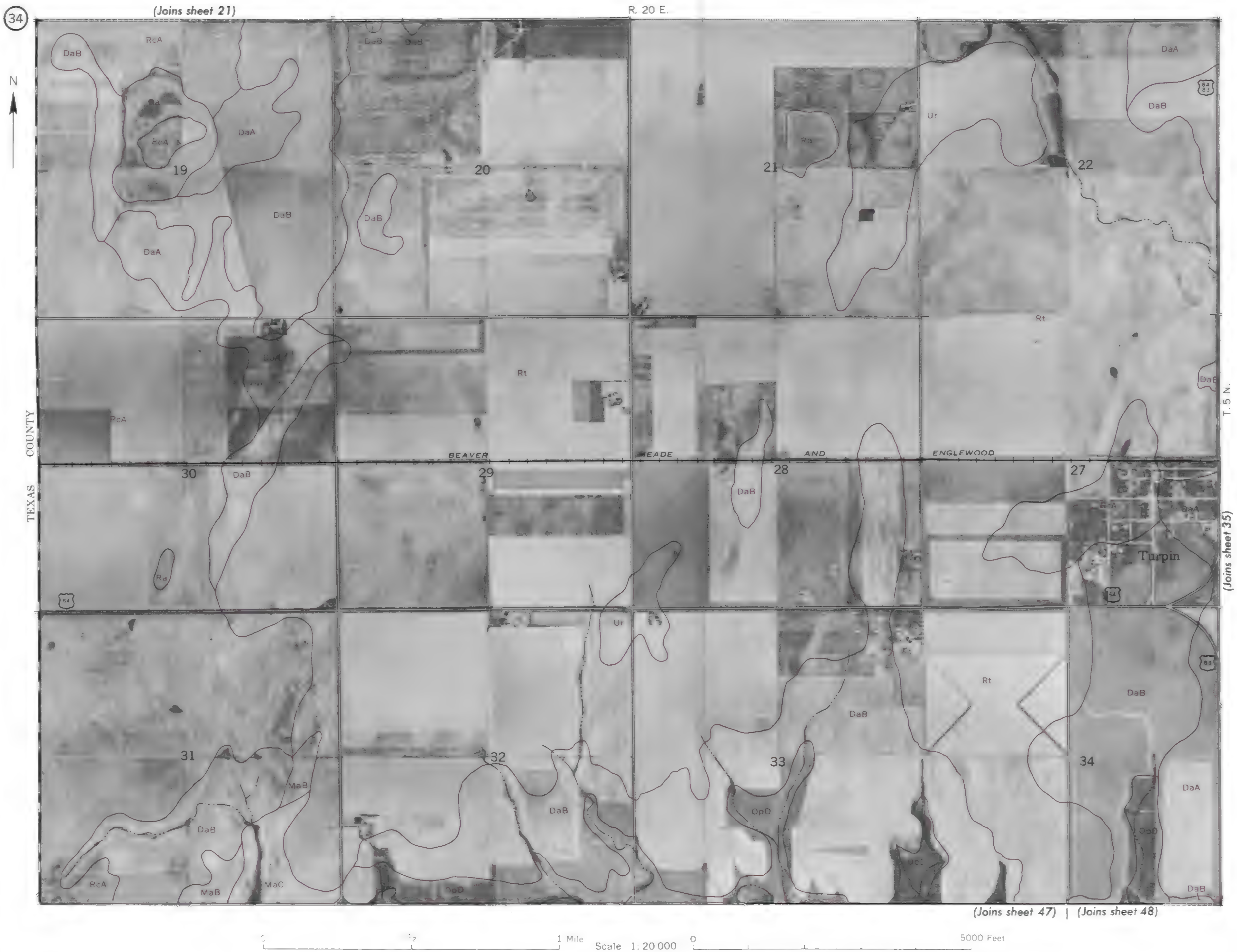
0 ½ 1 Mile

Scale 1:20 000

0 5000 Feet

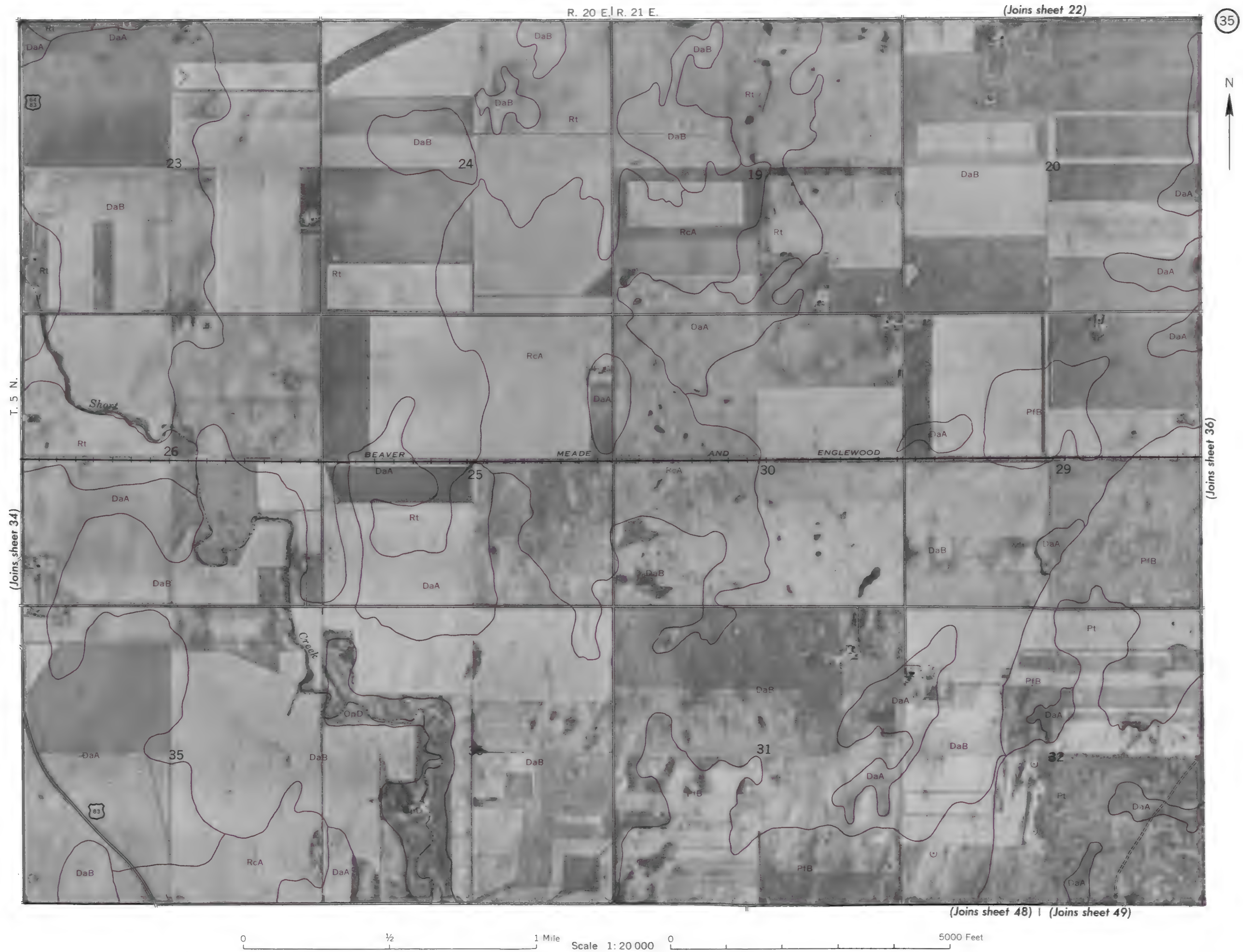
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


34
(Joins sheet 21)
R. 20 E.
N
T. 5 N.
TEXAS
COUNTY
BEAVER
MEADE
AND
ENGLEWOOD
Turpin
(Joins sheet 35)
(Joins sheet 47)
(Joins sheet 48)
19
20
21
22
27
28
29
30
31
32
33
34
DaB
RcA
DaA
Ur
Ra
Rt
OpD
MaB
MaC
1 Mile
Scale 1: 20 000
0
5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

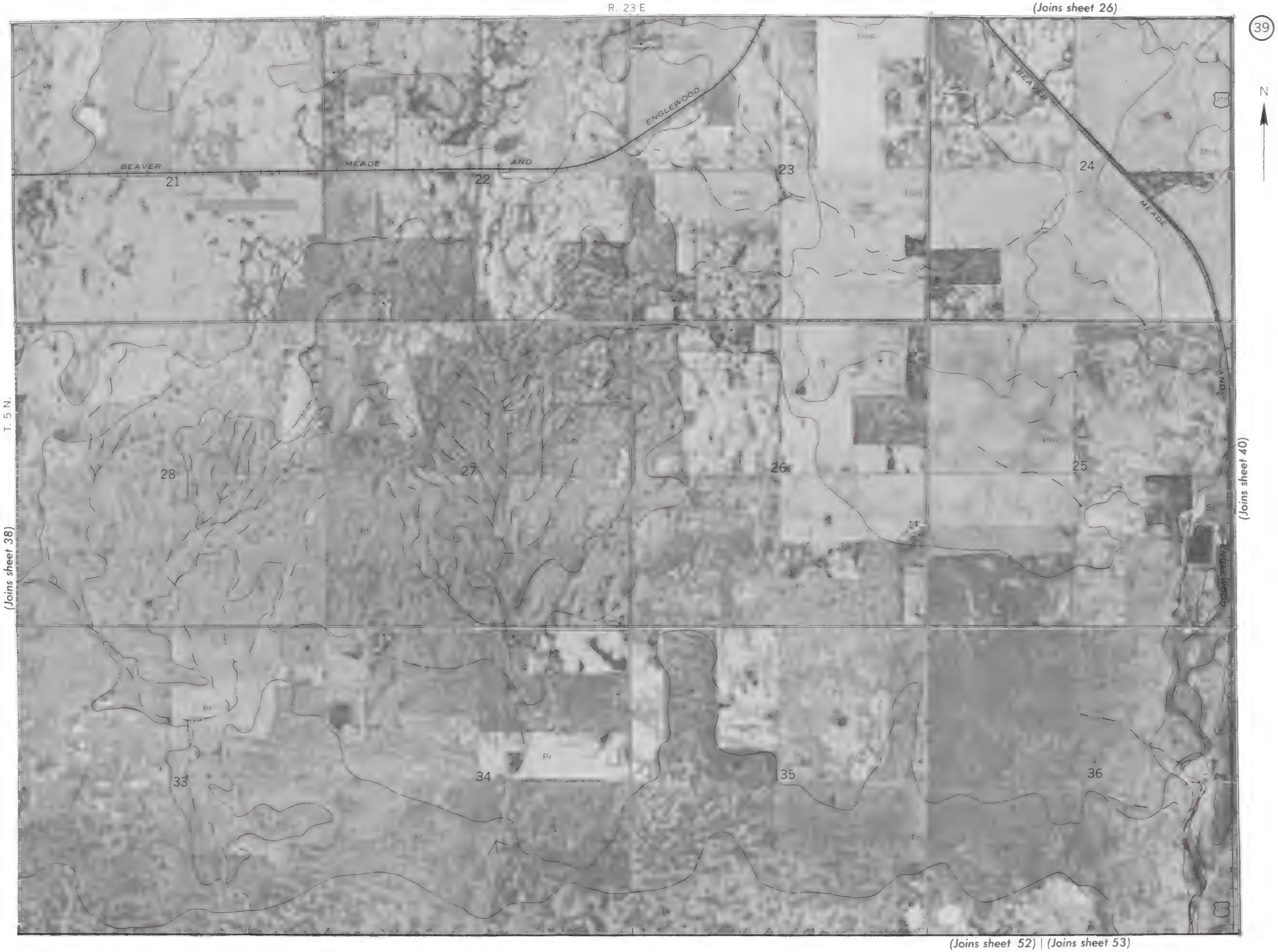


BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 36

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


38
(Joins sheet 25)
R. 22 E. | R. 23 E.
N
(Joins sheet 37)
(Joins sheet 39)
T. 5 N.
(Joins sheet 51)
(Joins sheet 52)
BEAVER
MEADE
AND
ENGLEWOOD
DaA
DaB
PfB
Pr
Pt
Tv
23
24
19
20
26
25
30
29
35
36
31
32
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

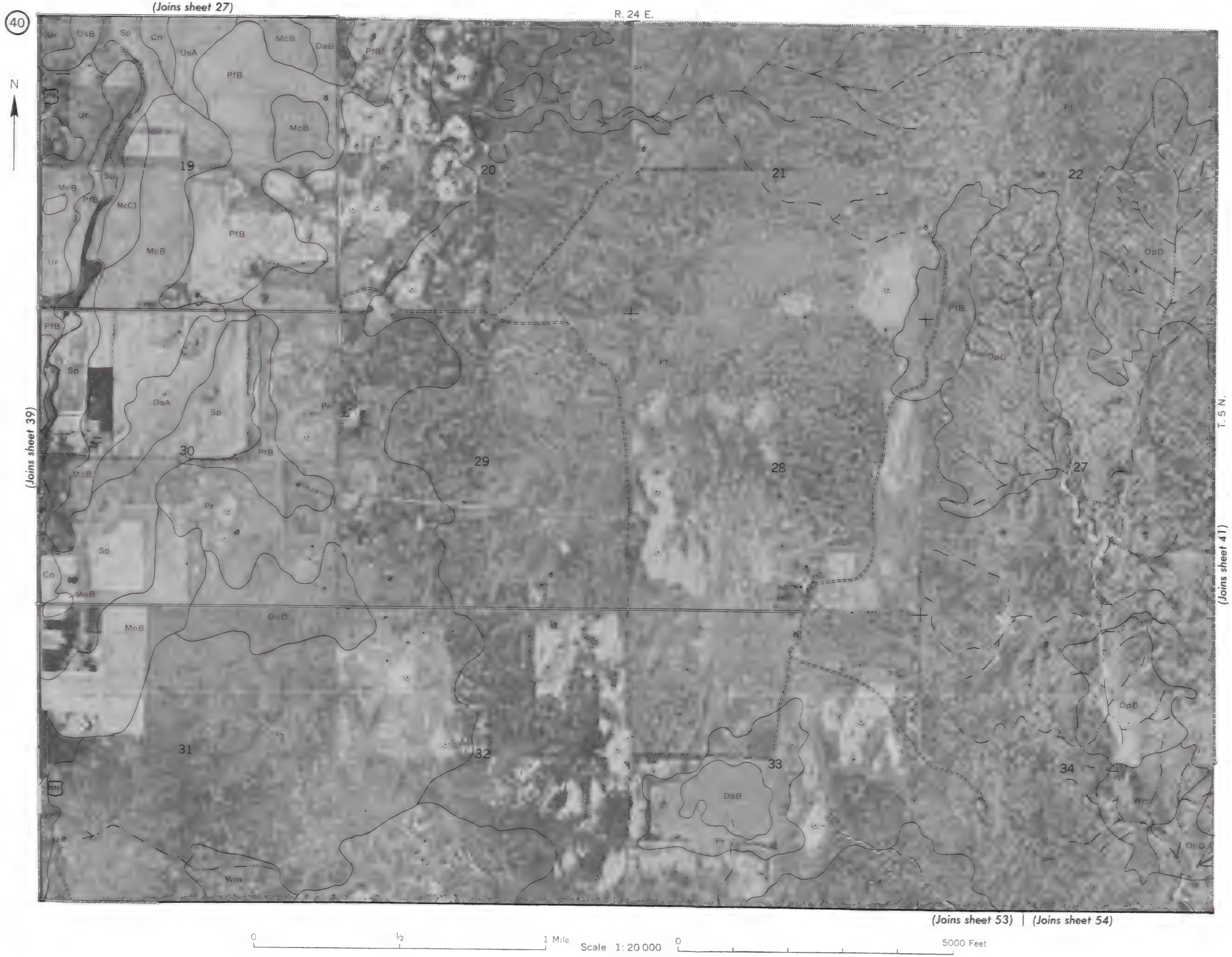


0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 40



BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 41

41

R. 24 E. | R. 25 E.

(Joins sheet 28)

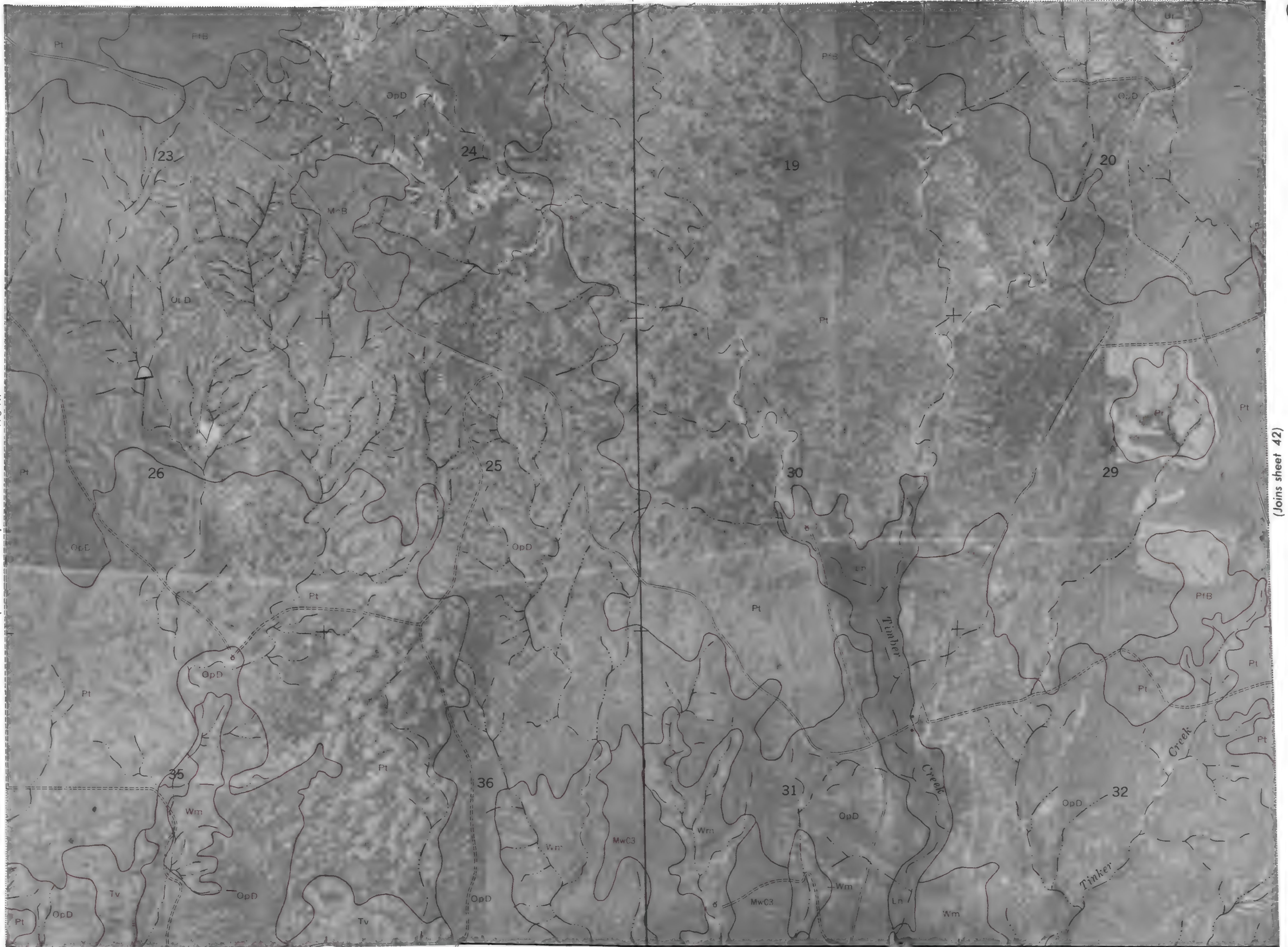
N

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

T. 5 N.

(Joins sheet 40)



(Joins sheet 42)

(Joins sheet 54) | (Joins sheet 55)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

42

(Joins sheet 29)

R. 25 E.

N

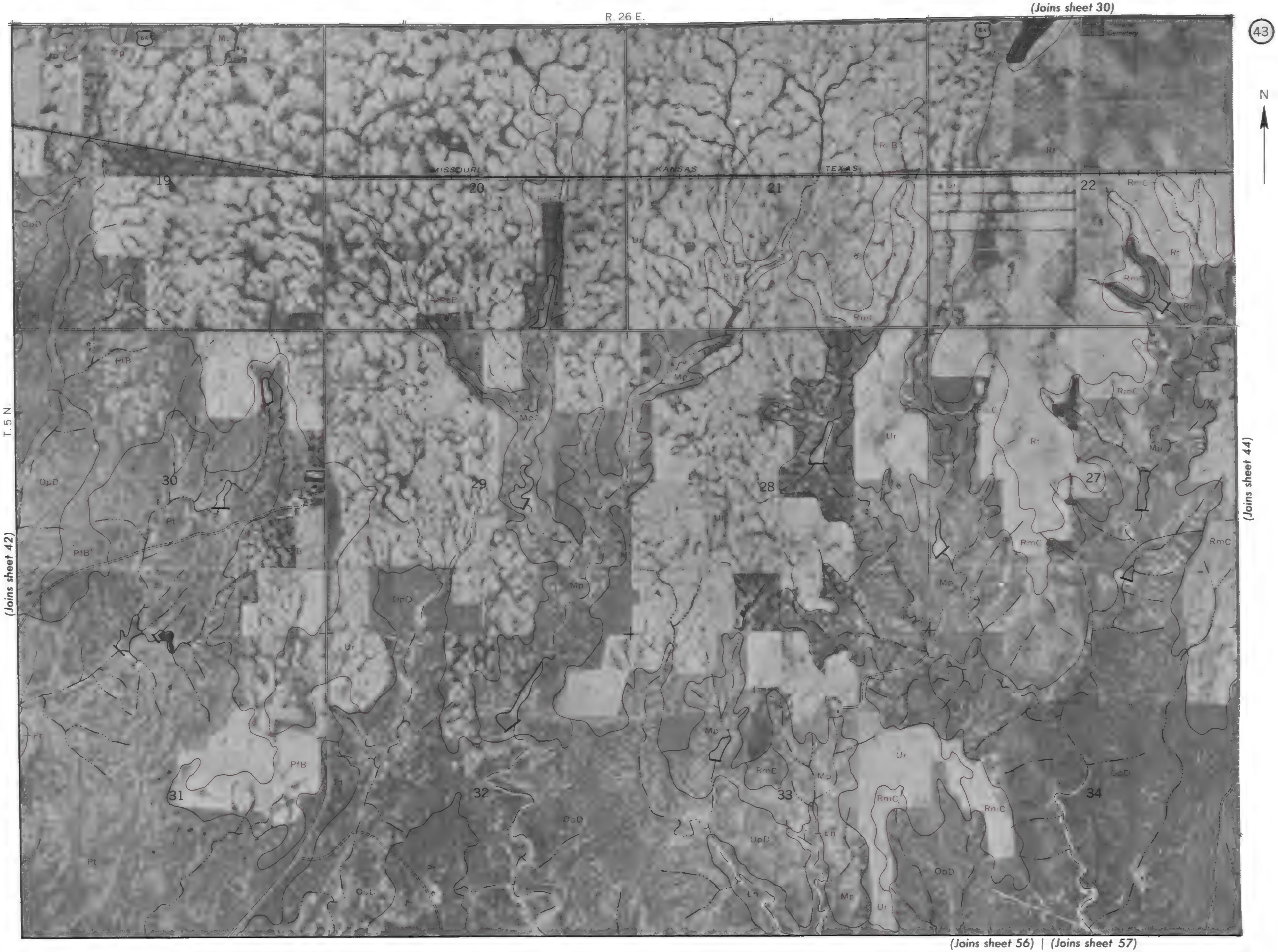
(Joins sheet 41)

T. 5 N.

(Joins sheet 43)

(Joins sheet 55) | (Joins sheet 56)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

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0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


44
(Joins sheet 31)
R. 26 E. | R. 27 E.
N
(Joins sheet 43)
(Joins sheet 45)
T. 5 N.
Knowles
MISSOURI
KANSAS
TEXAS
23
24
19
20
26
25
30
29
35
36
31
32
(Joins sheet 57) | (Joins sheet 58)
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 45

R. 27 E.

(Joins sheet 32)

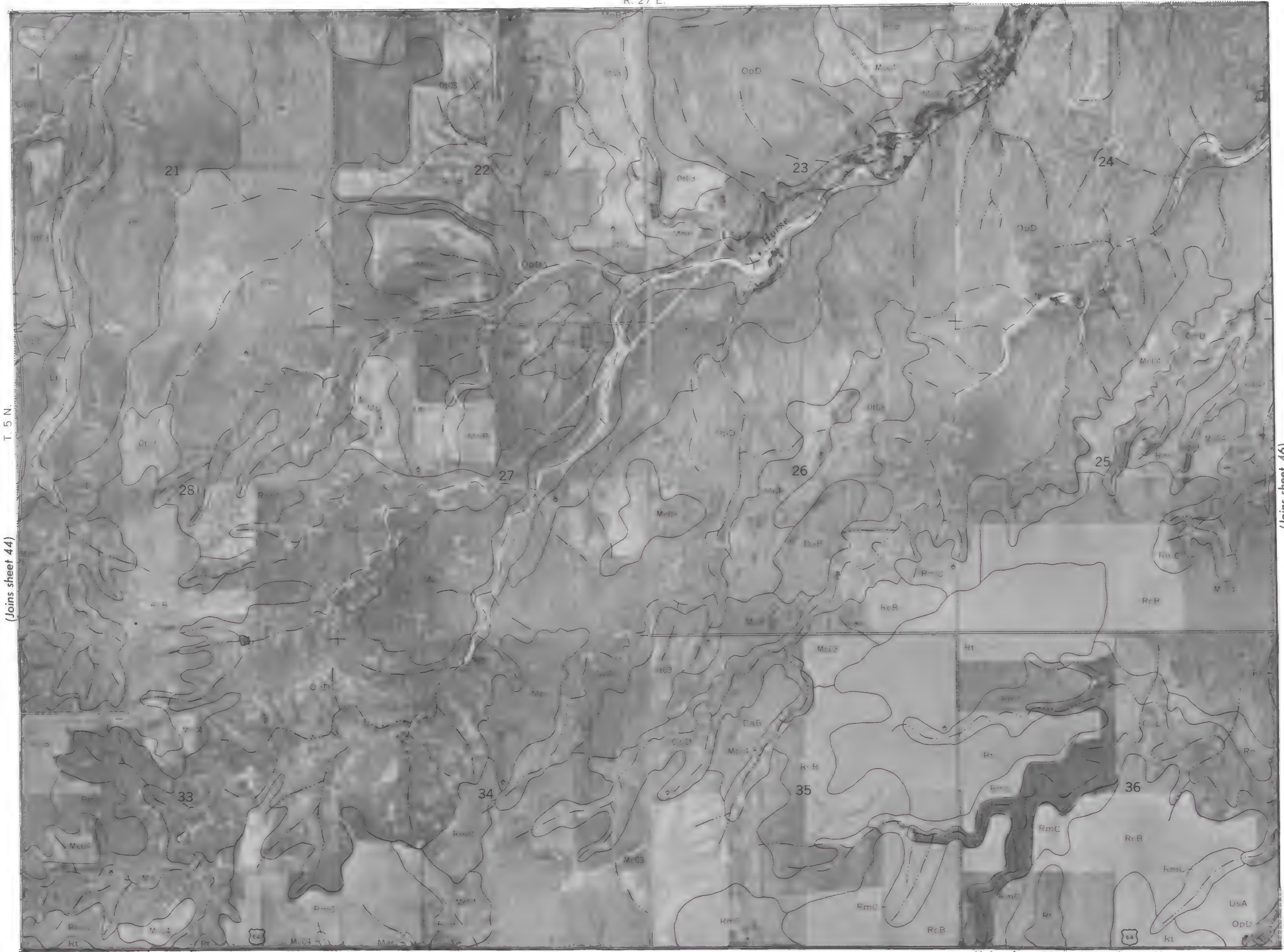
45

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite.

T. 5 N.

(Joins sheet 44)



(Joins sheet 46)

(Joins sheet 58) | (Joins sheet 59)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


46
(Joins sheet 33)
R. 28 E.
N
(Joins sheet 45)
T. 5 N.
HARPER COUNTY
(Joins sheet 59)
(Joins inset, sheet 86)
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Gate
KANSAS
TEXAS
MISSOURI
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

R. 20 E.

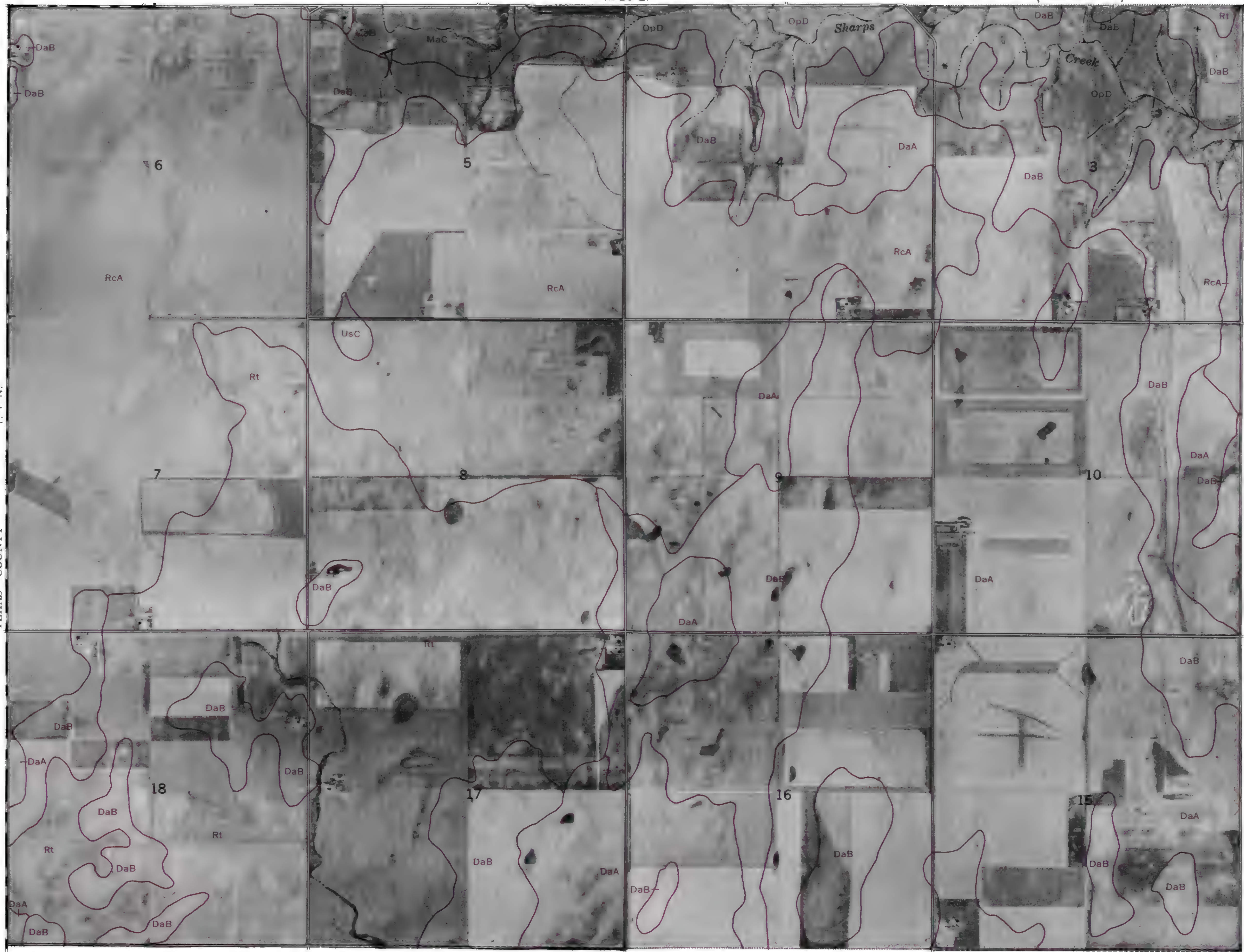
(Joins sheet 34)

47

N

T. 4 N.

TEXAS COUNTY



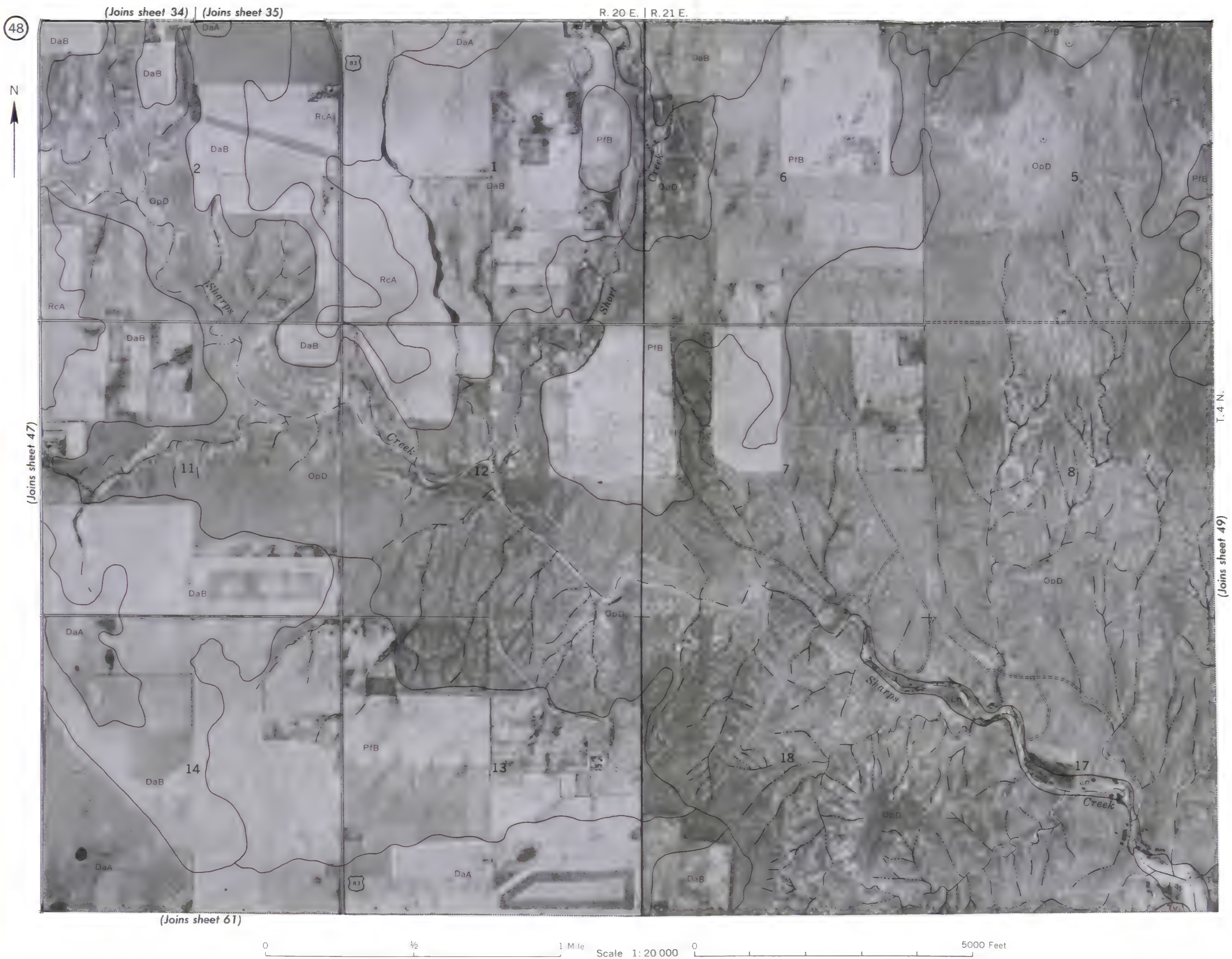
(Joins sheet 48)

(Joins sheet 60)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


48
(Joins sheet 34) | (Joins sheet 35)
R. 20 E. | R. 21 E.
N
(Joins sheet 47)
(Joins sheet 49)
T. 4 N.
(Joins sheet 61)
DaB
DaA
RcA
OpD
PfB
Sharps
Creek
Short
1
2
5
6
7
8
11
12
13
14
17
18
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

49

(Joins sheet 35) | *(Joins sheet 36)*

R. 21 E.

T. 4 N.

(Joins sheet 48)

(Joins sheet 50)

(Joins sheet 62)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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Range, township, and section corners shown on this map are indefinite.

50

(Joins sheet 36) | (Joins sheet 37)

R. 22 E.

N

(Joins sheet 49)

T. 4 N.

(Joins sheet 51)

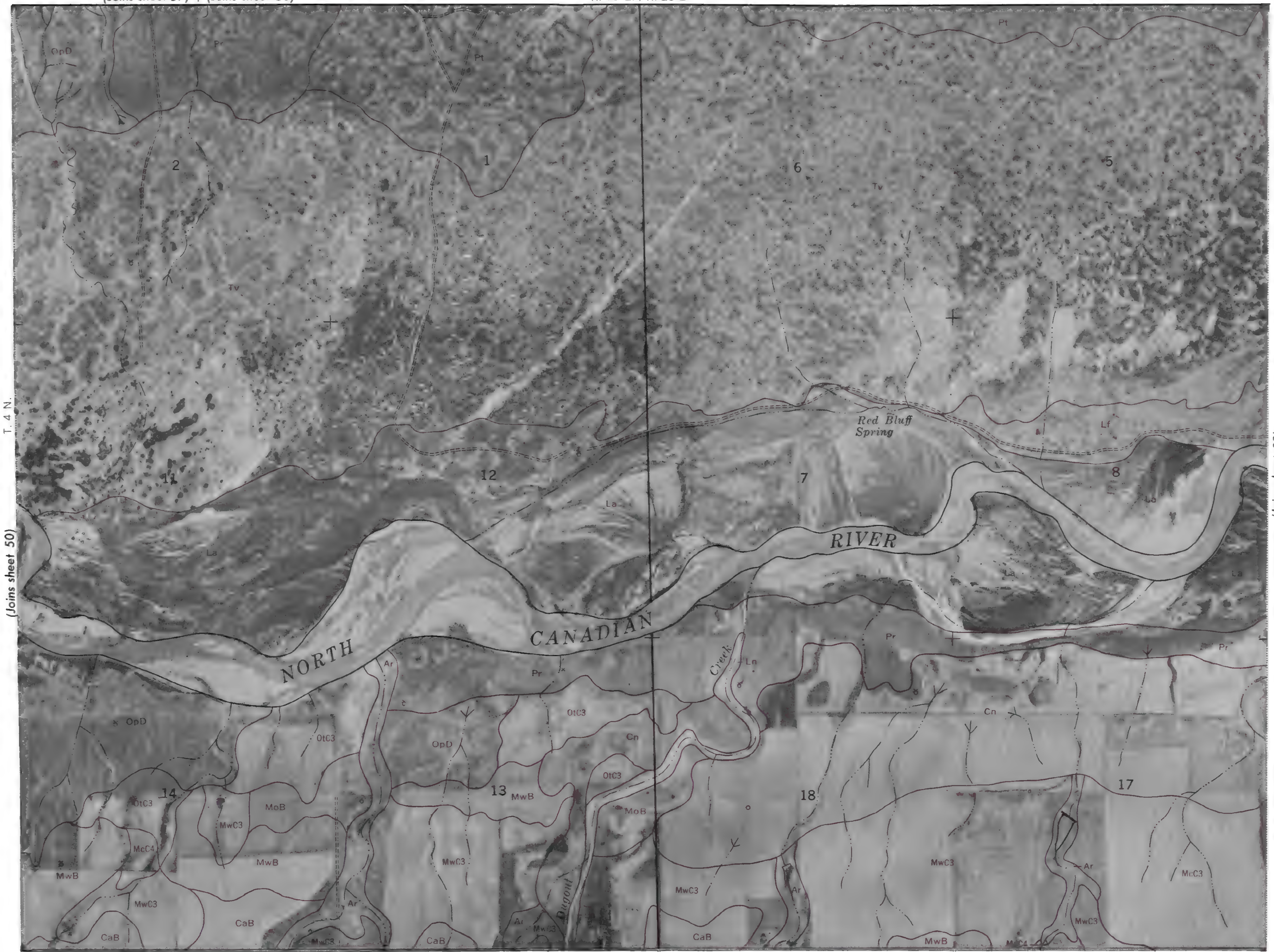
(Joins sheet 63)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 37) | (Joins sheet 38)

R. 22 E. | R. 23 E.

51



(Joins sheet 50)

(Joins sheet 52)

(Joins sheet 64)

0 ½ 1 Mile Scale 1:20 000 0 5 000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

(Joins sheet 38) | (Joins sheet 39)

(Joins sheet 65)

1 Mile   Scale 1: 20 000   0   5000 Feet

(Joins sheet 39) | (Joins sheet 40)

R. 24 E.

53

T. 4 N.

(Joins sheet 52)

(Joins sheet 54)

(Joins sheet 66)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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Range, township, and section corners shown on this map are indefinite.

54

(Joins sheet 40) | (Joins sheet 41)

R. 24 E. | R. 25 E.

N

(Joins sheet 53)

(Joins sheet 55)

(Joins sheet 67)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

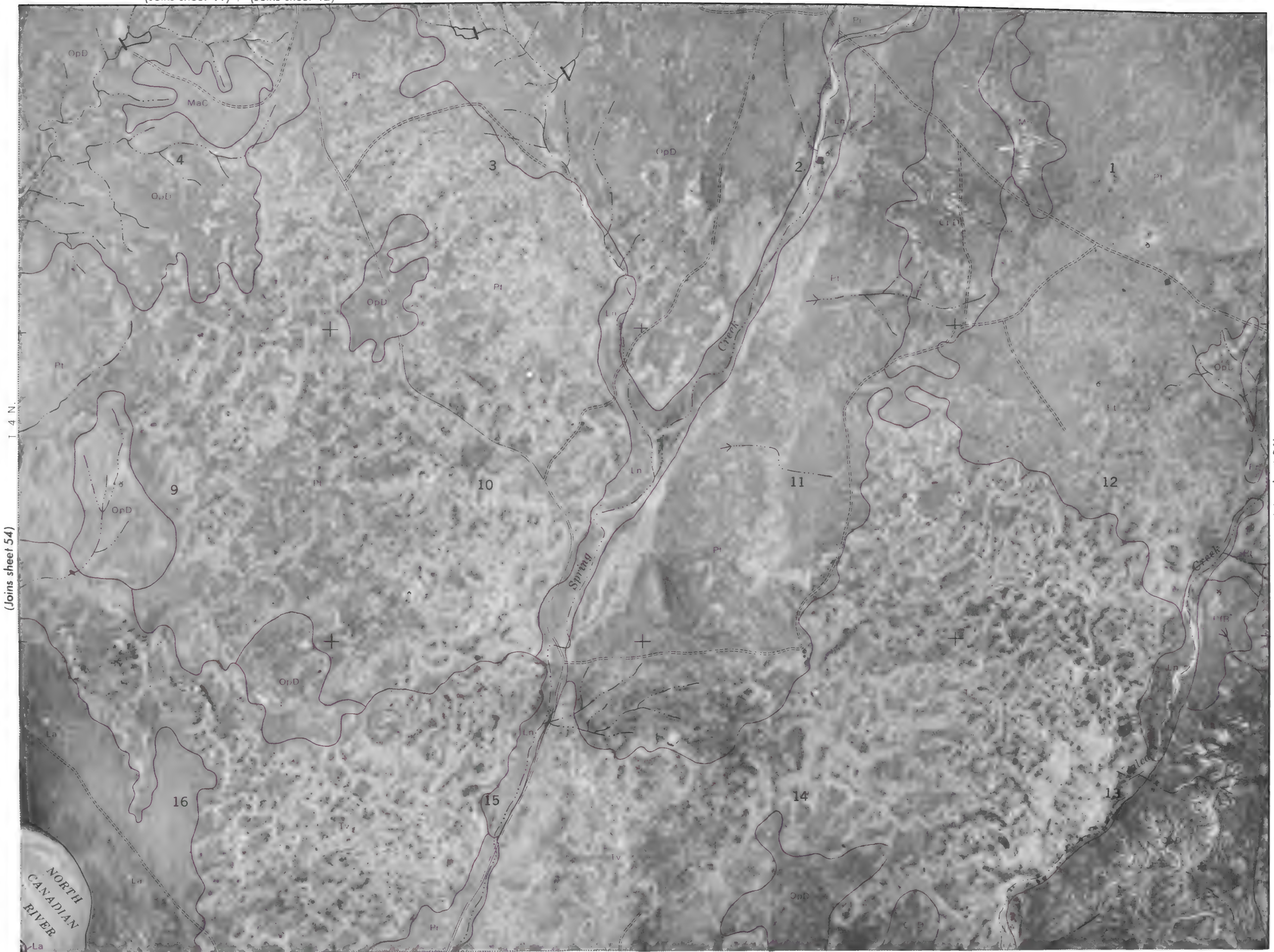
(Joins sheet 41) | (Joins sheet 42)

R. 25 E.

55

T. 4 N.

(Joins sheet 54)



(Joins sheet 56)

(Joins sheet 68)

N

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

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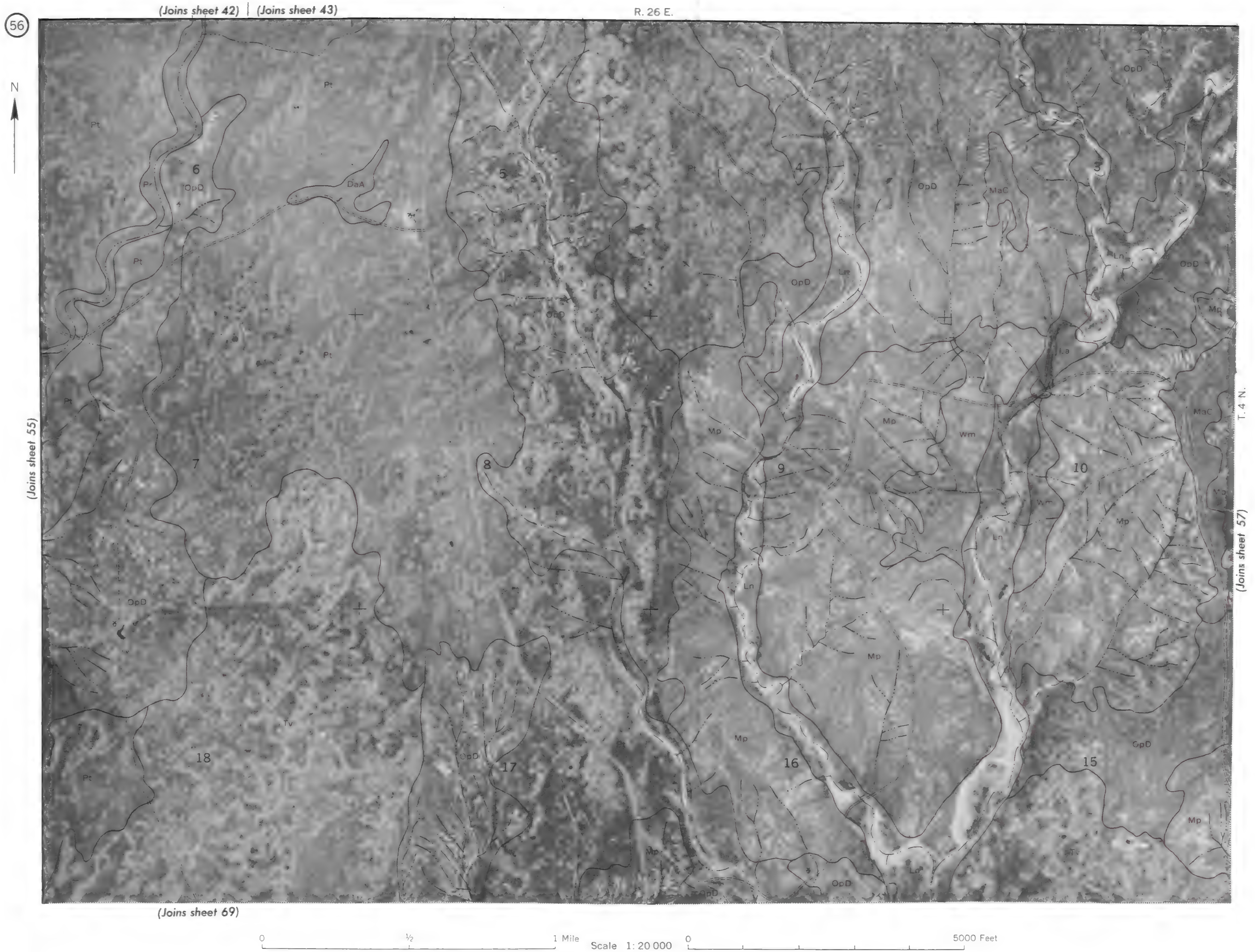
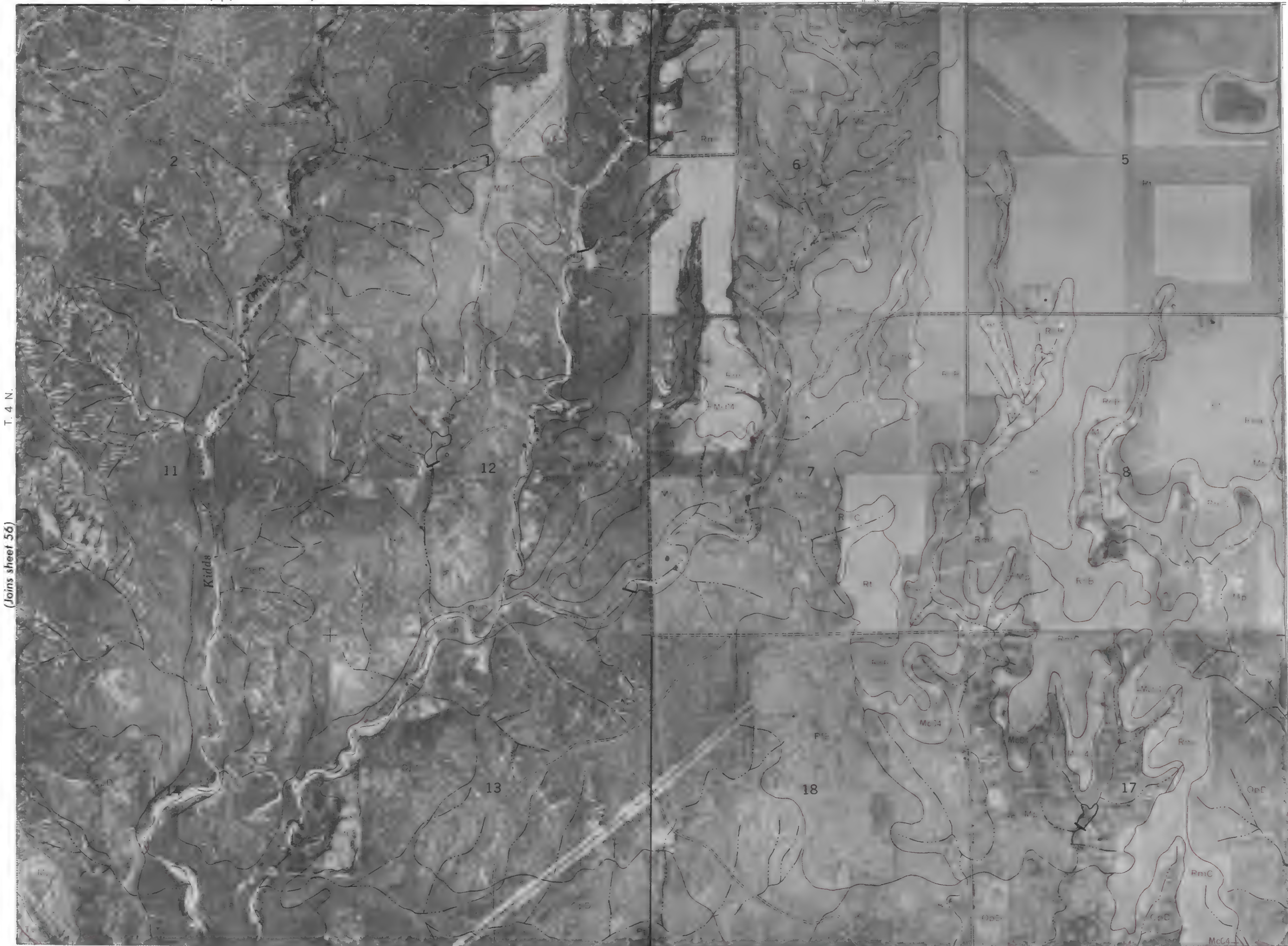

56
(Joins sheet 42)
(Joins sheet 43)
R. 26 E.
N
(Joins sheet 55)
(Joins sheet 57)
T. 4 N.
(Joins sheet 69)
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

(Joins sheet 43) | (Joins sheet 44)

R. 26 E. | R. 27 E.



(Joins sheet 70)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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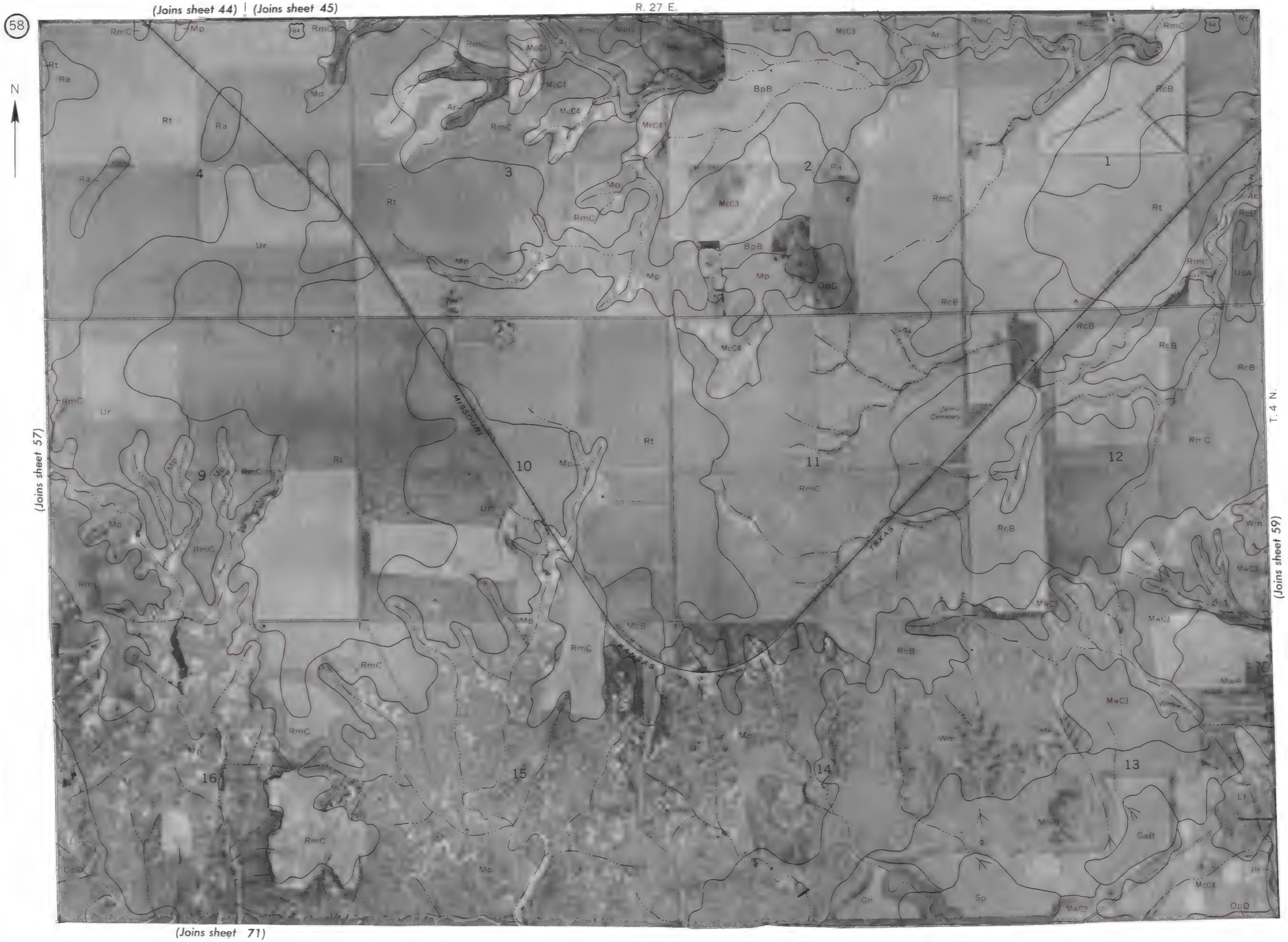
Range, township, and section corners shown on this map are indefinite.



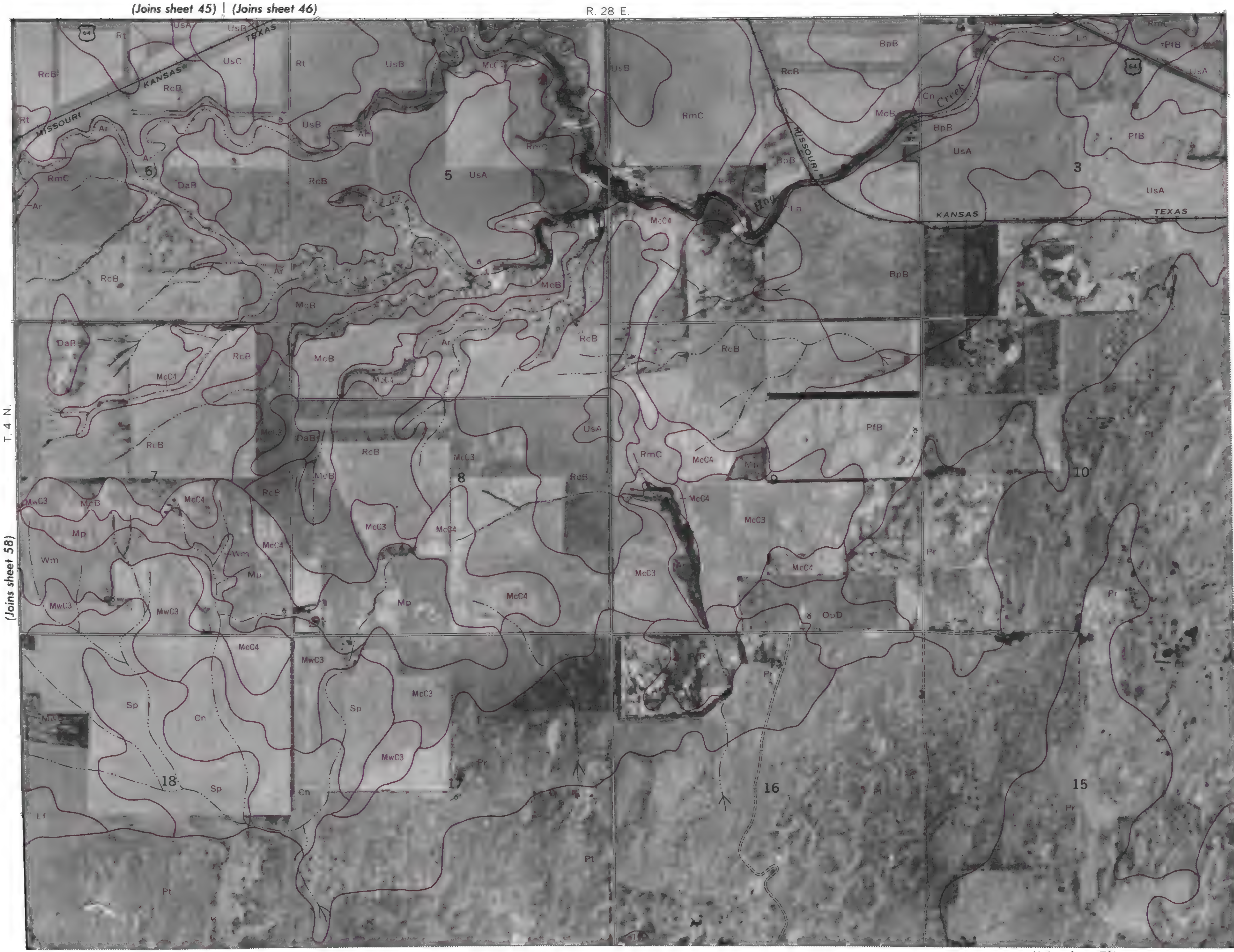
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 59

59

(Joins sheet 45) | *(Joins sheet 46)*

R. 28 E.



N

(Joins sheet 58)

(Joins inset, sheet 86)

(Joins sheet 72)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet


60
(Joins sheet 47)
R. 20 E.
N
TEXAS COUNTY
T. 4 N.
(Joins sheet 61)
(Joins sheet 73)
19
20
21
22
30
29
28
27
31
32
33
34
DaA
DaB
Rt
RcA
MaB
MaC
Scale 1:20 000
0
5000 Feet

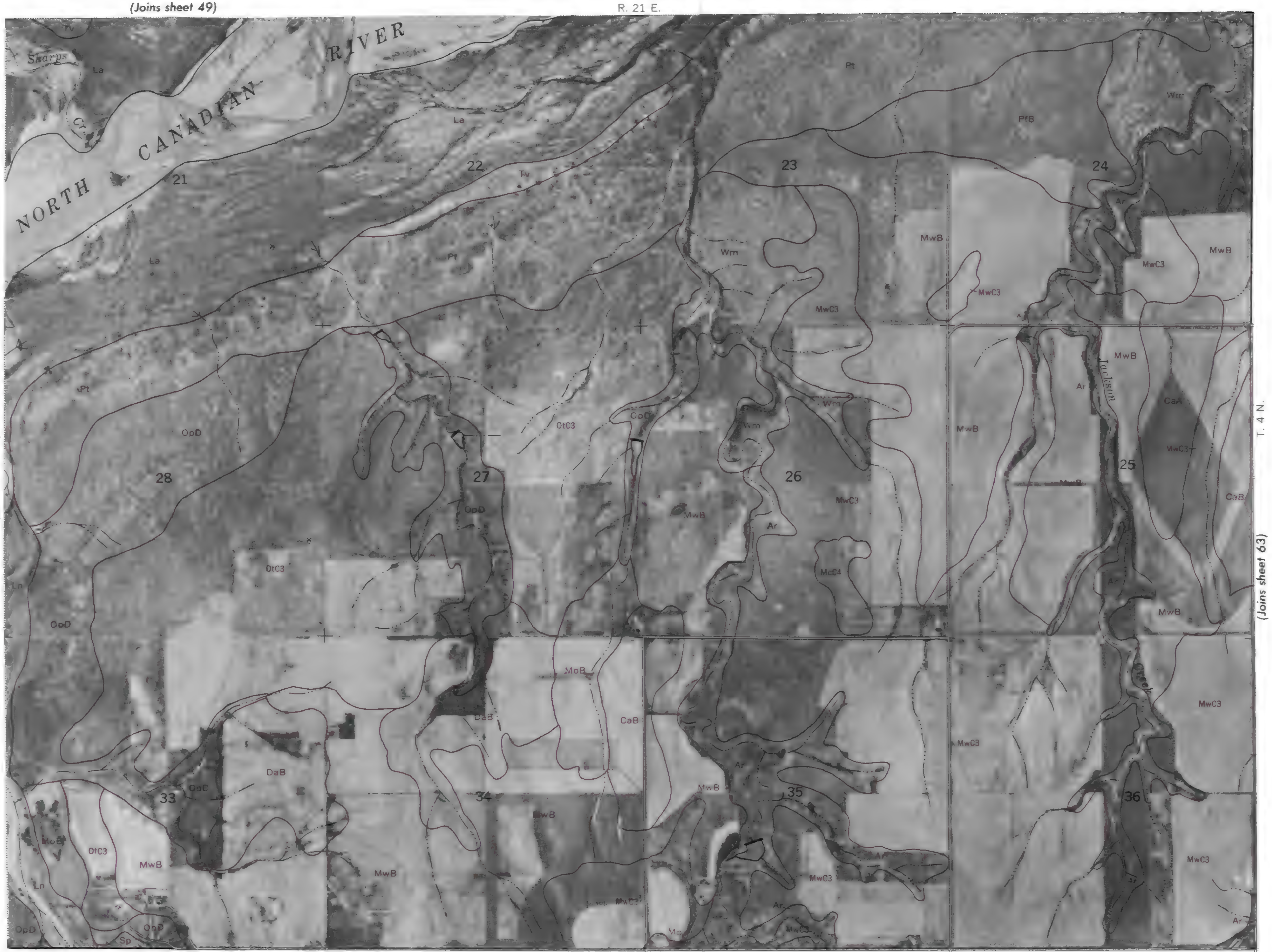
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

(62)

(Joins sheet 49)

R. 21 E.



(Joins sheet 75)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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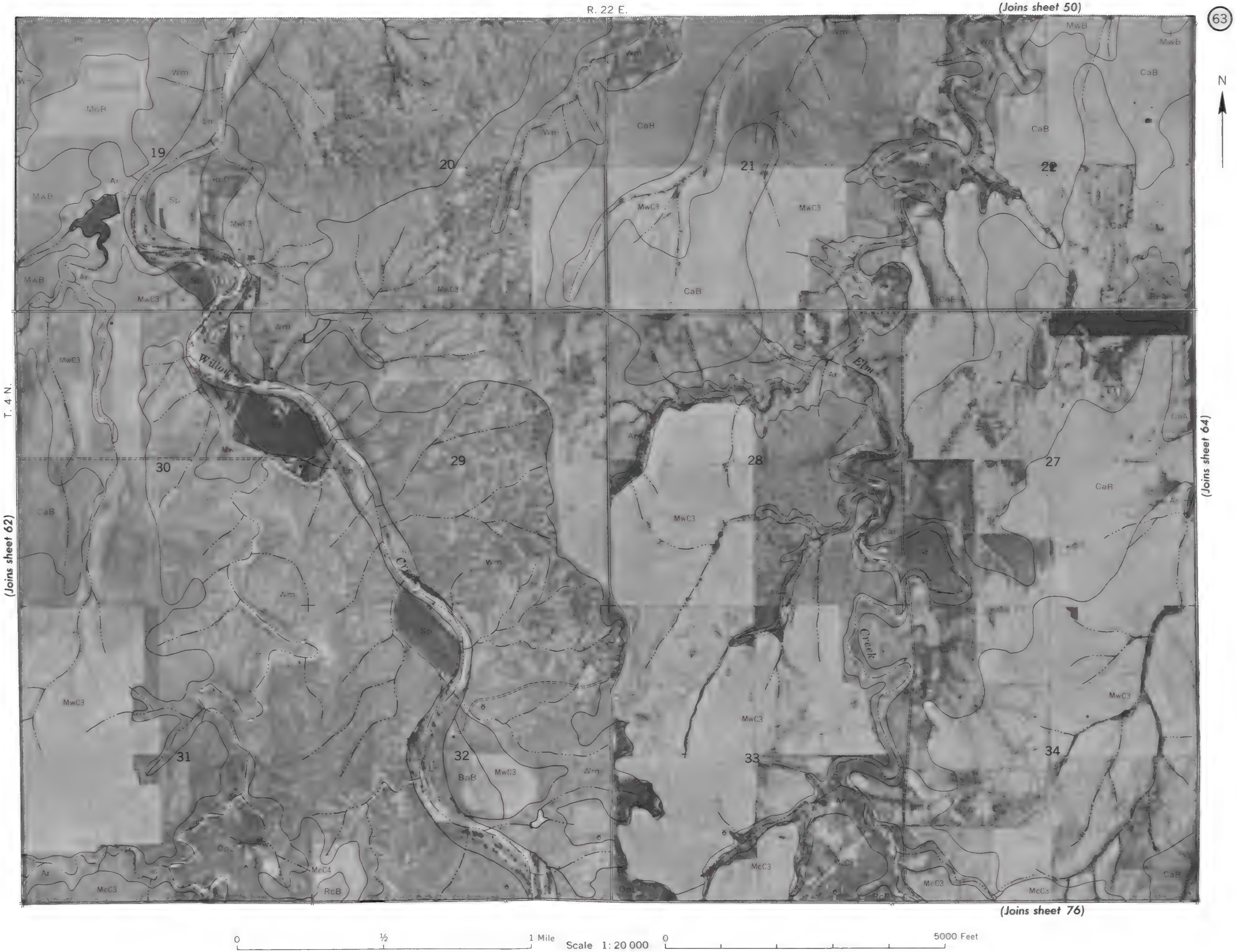
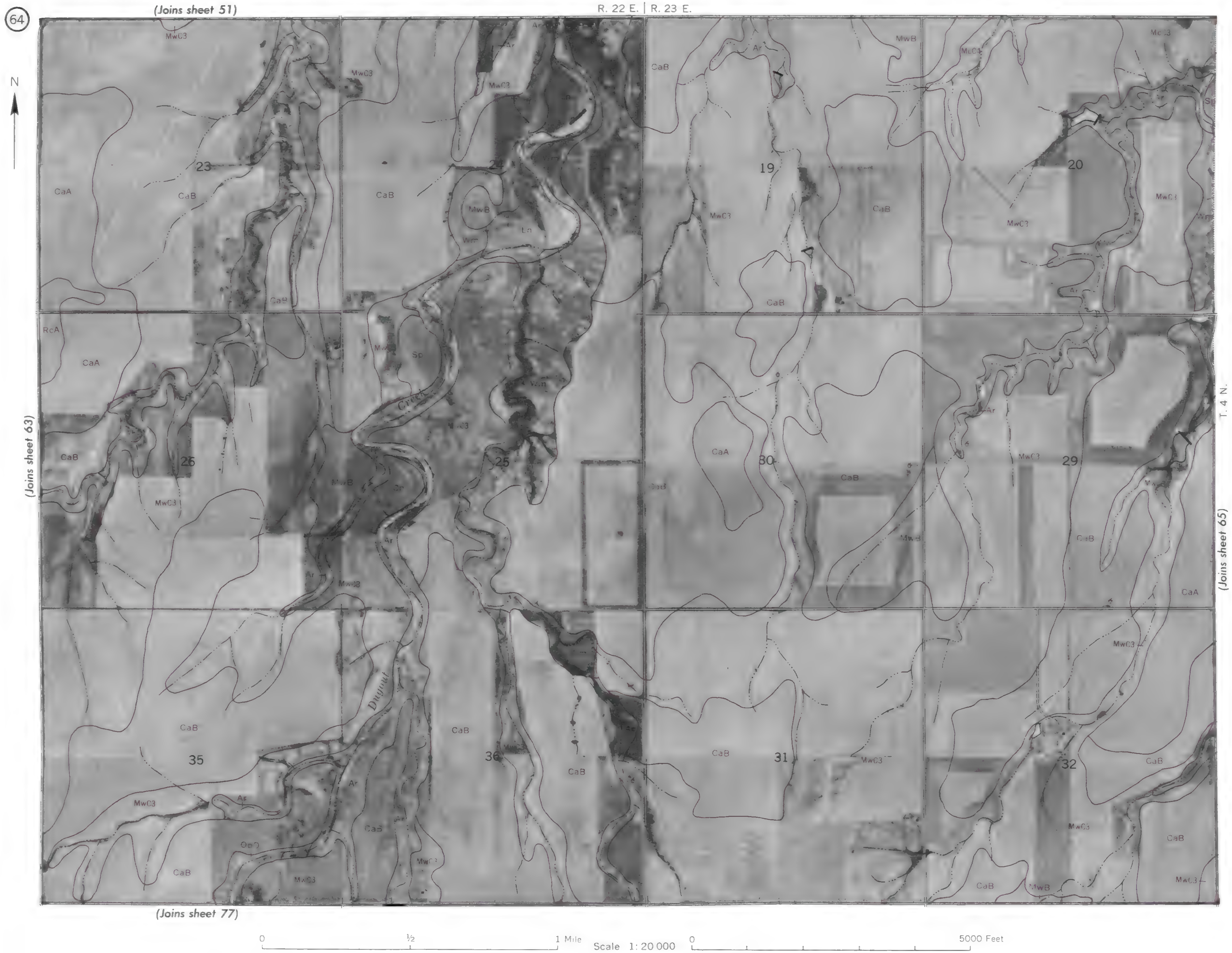
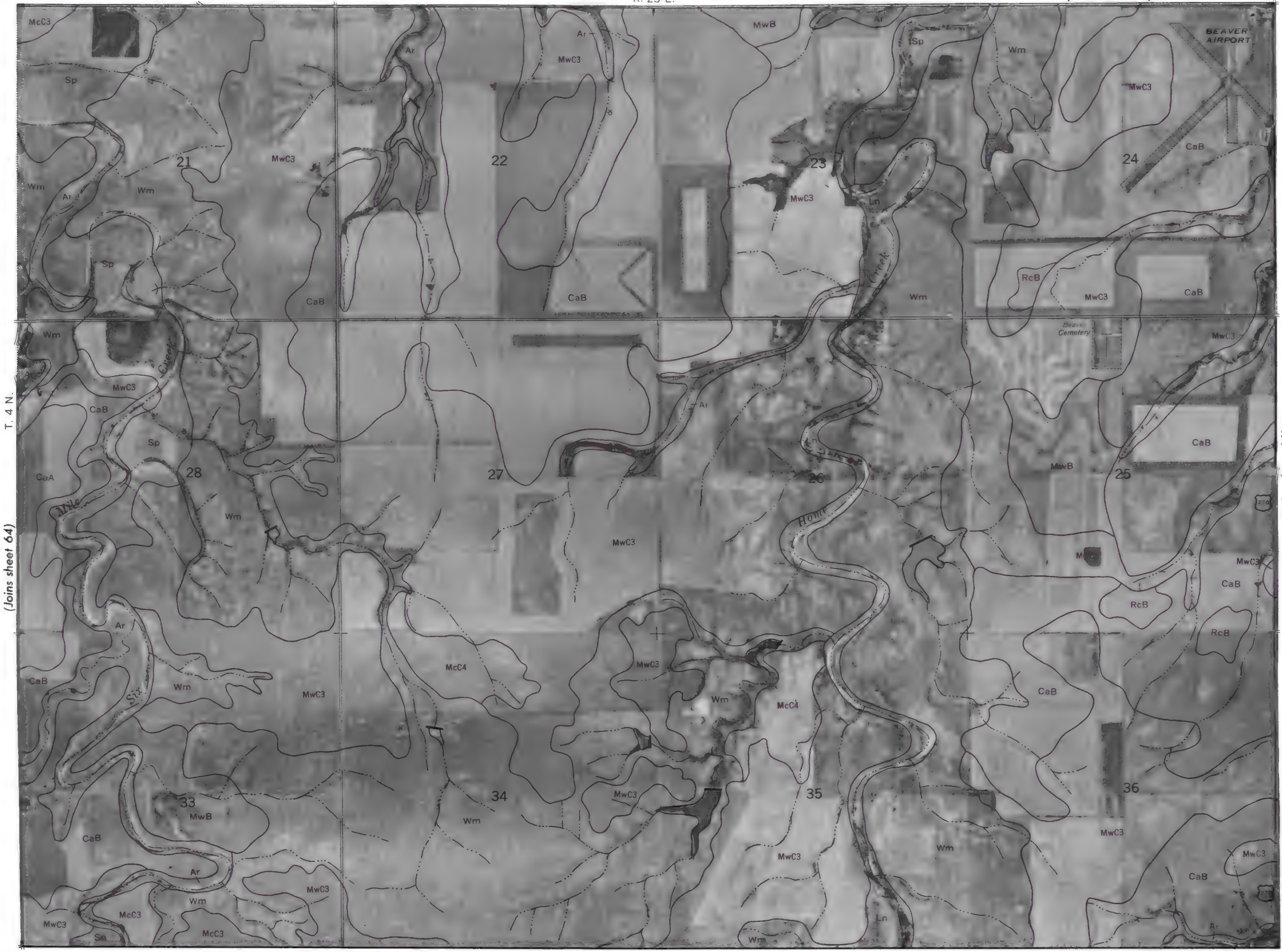
Range, township, and section corners shown on this map are indefinite.



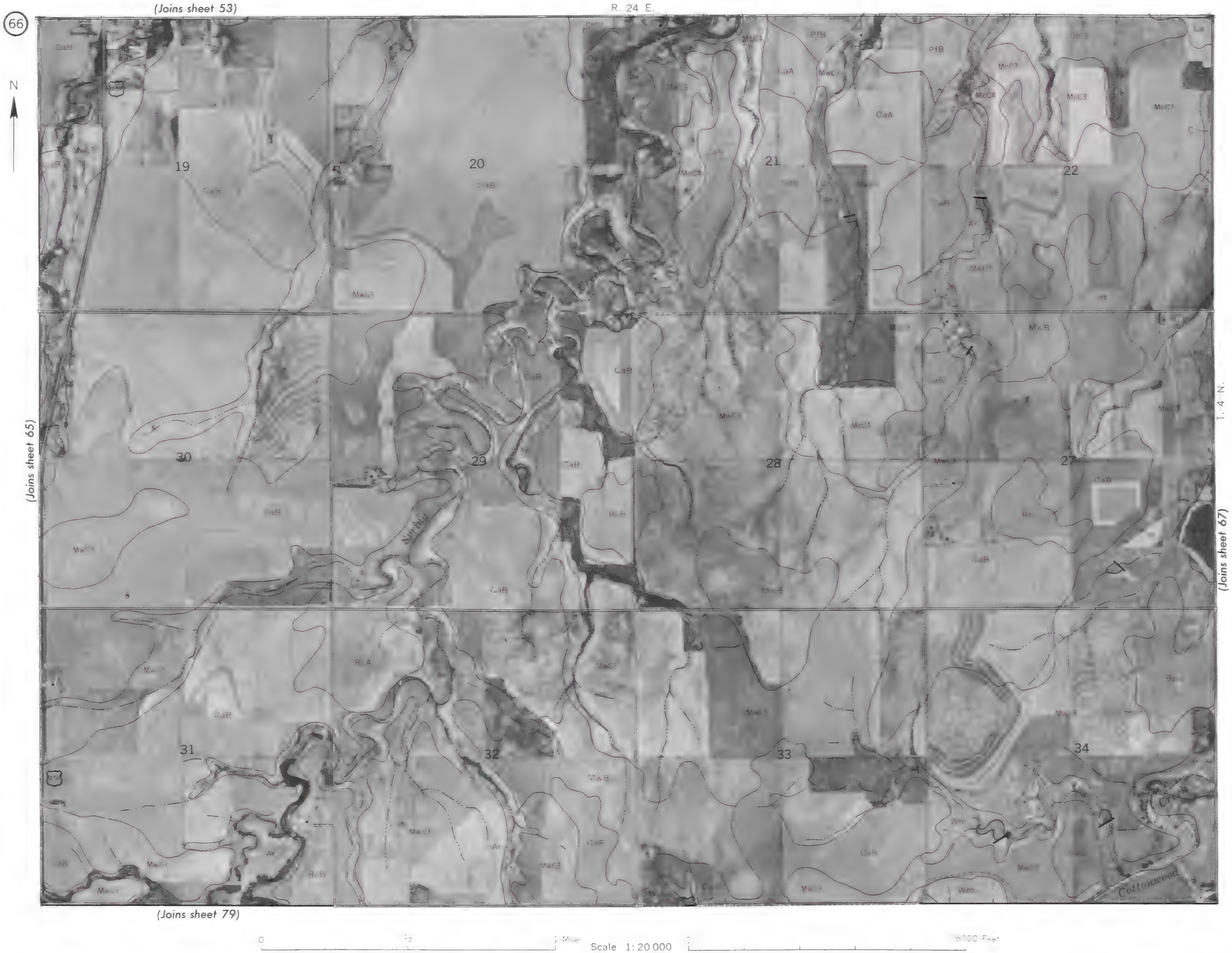

64
(Joins sheet 51)
R. 22 E. | R. 23 E.
N
(Joins sheet 63)
(Joins sheet 65)
T. 4 N.
(Joins sheet 77)
23
24
19
20
26
25
30
29
35
36
31
32
CaA
CaB
MwC3
MwB
Ar
RcA
Sp
Dugout
Creek
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

Range, township, and section corners shown on this map are indefinite.



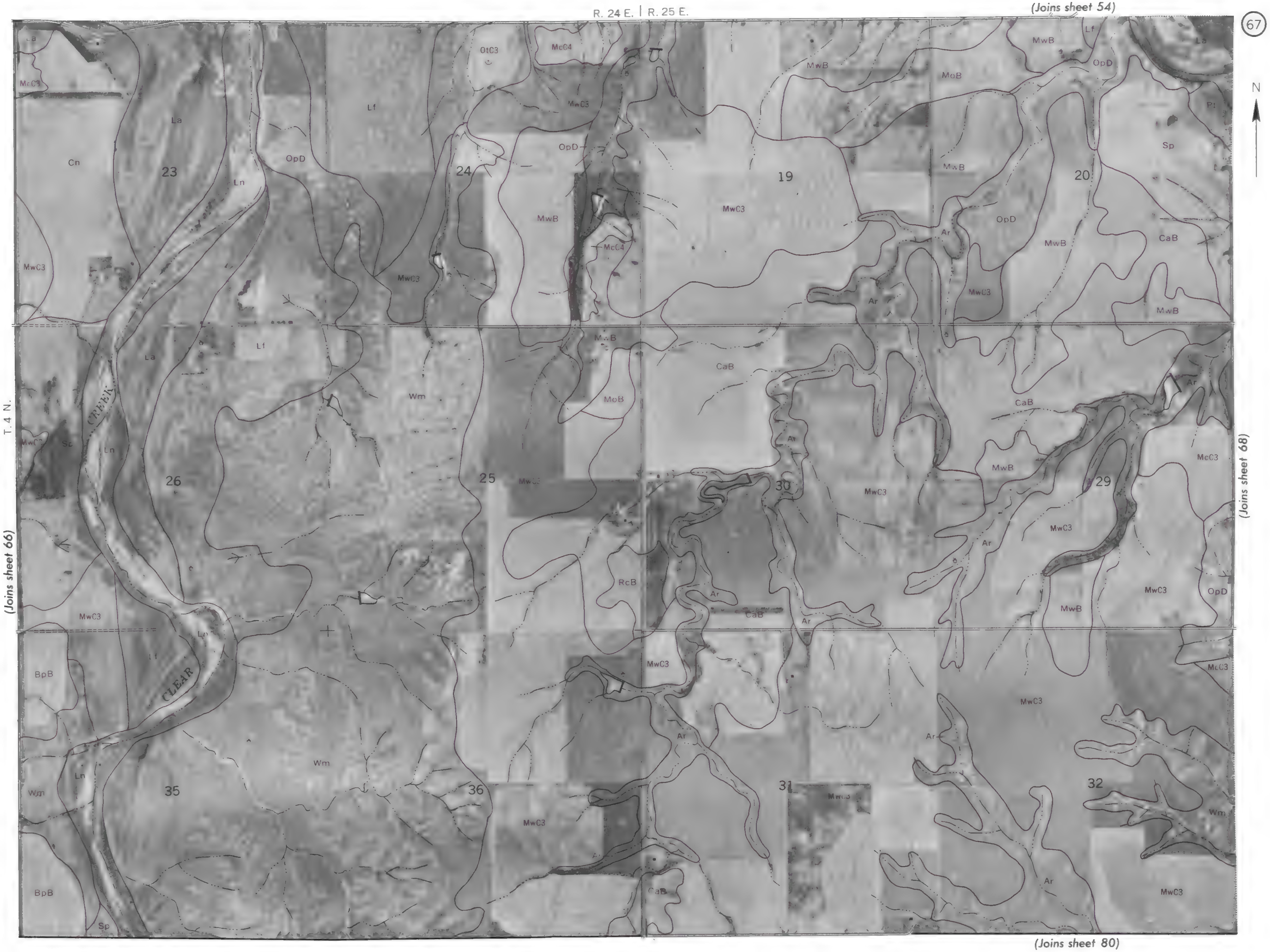
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 66



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953

Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 55)

R. 25 E.

68

(Joins sheet 67)

T. 4 N.

(Joins sheet 69)

(Joins sheet 81)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 26 E.

(Joins sheet 56)

69

T. 4 N.

(Joins sheet 68)

(Joins sheet 70)

(Joins sheet 82)

N

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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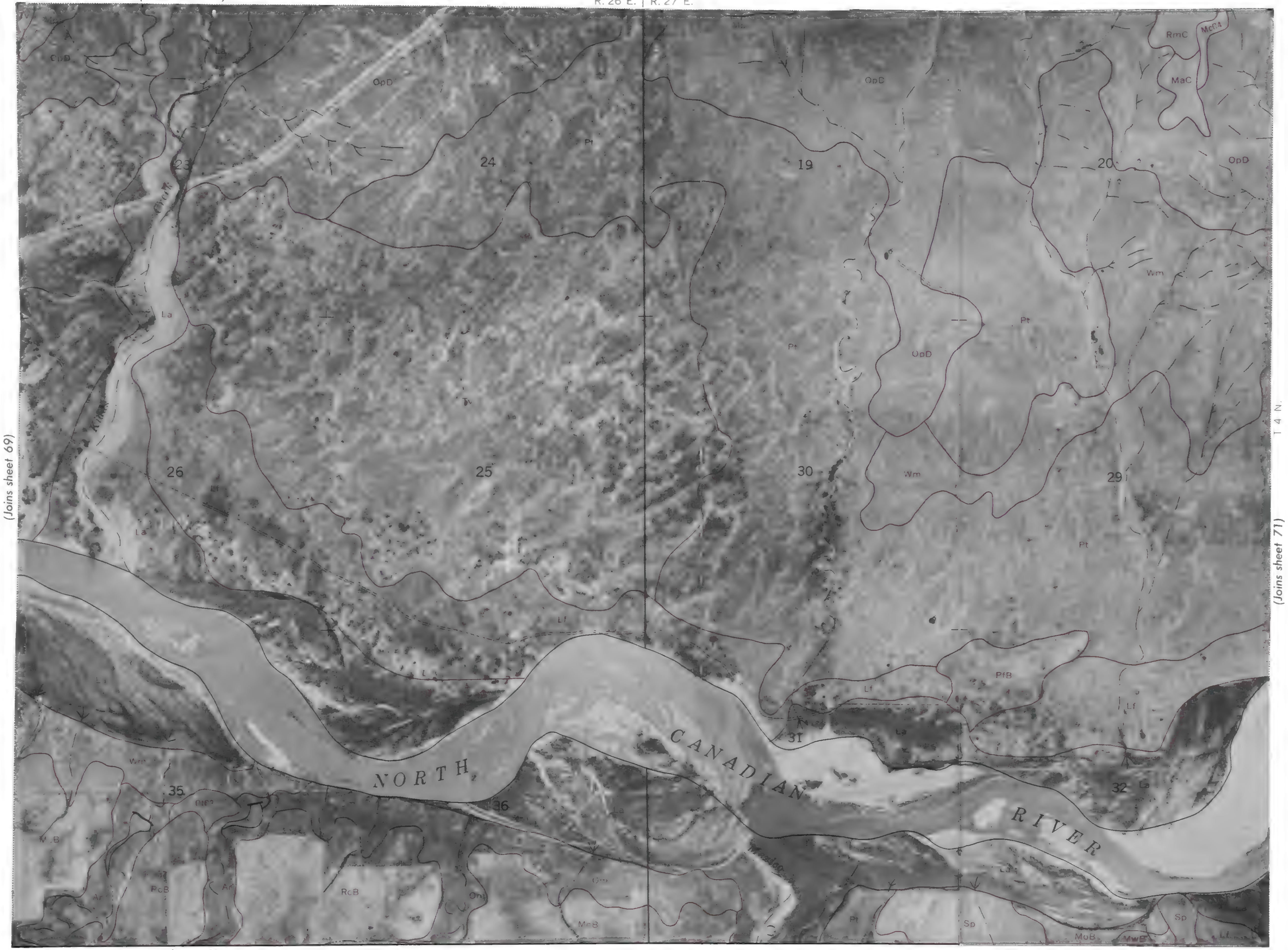
Range, township, and section corners shown on this map are indefinite.

(Joins sheet 57)

70



(Joins sheet 69)

(Joins sheet 71)

(Joins sheet 83)

Scale 1: 20 000 0 5000 Feet

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Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 28 E.

(Joins sheet 59)

(Joins sheet 71)

(Joins inset, sheet 86)

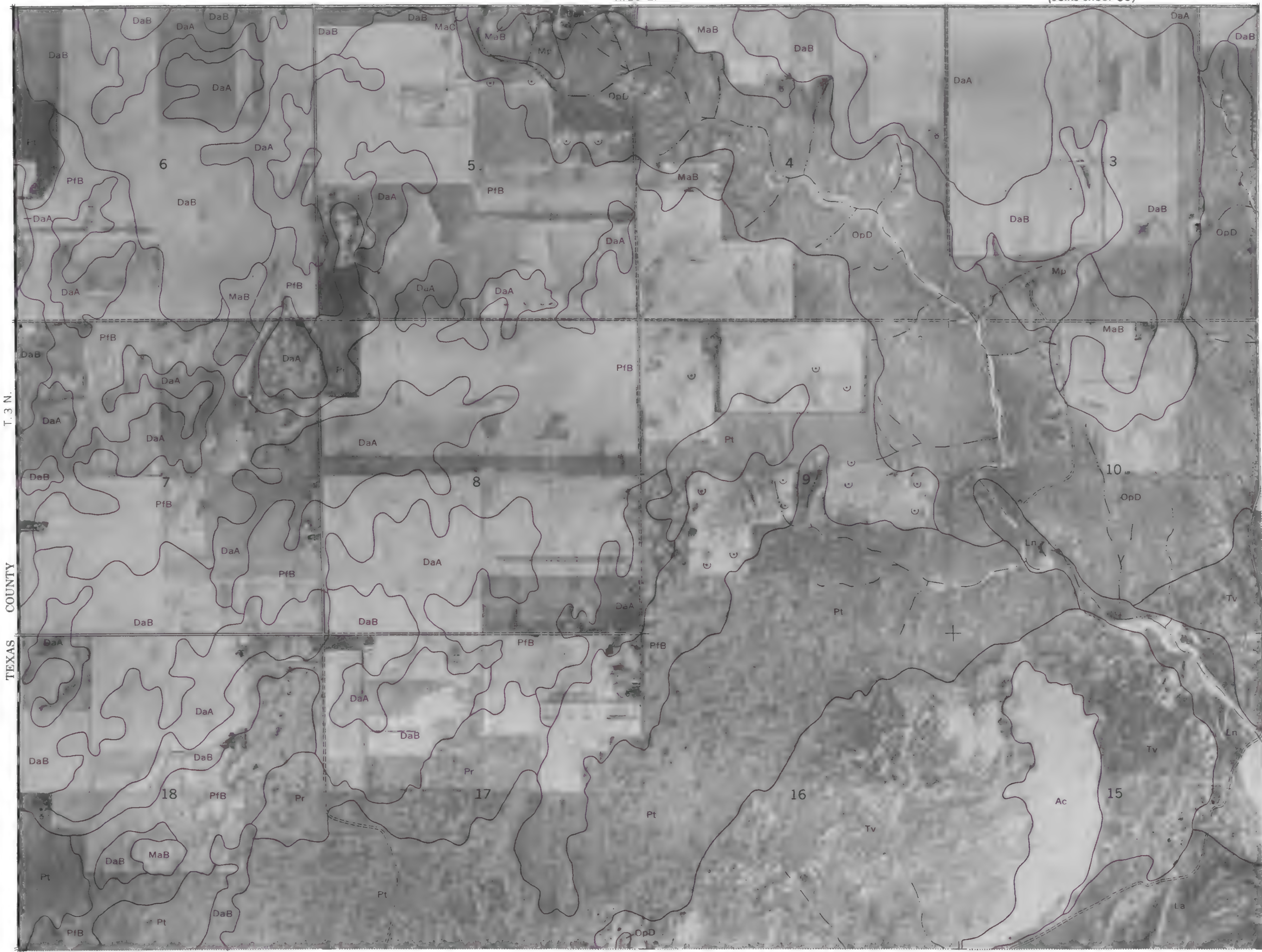
(Joins sheet 85)

½ 1 Mile Scale 1:20 000 0 5000 Feet

R. 20 E.

(Joins sheet 60)

73



(Joins sheet 74)

(Joins sheet 87)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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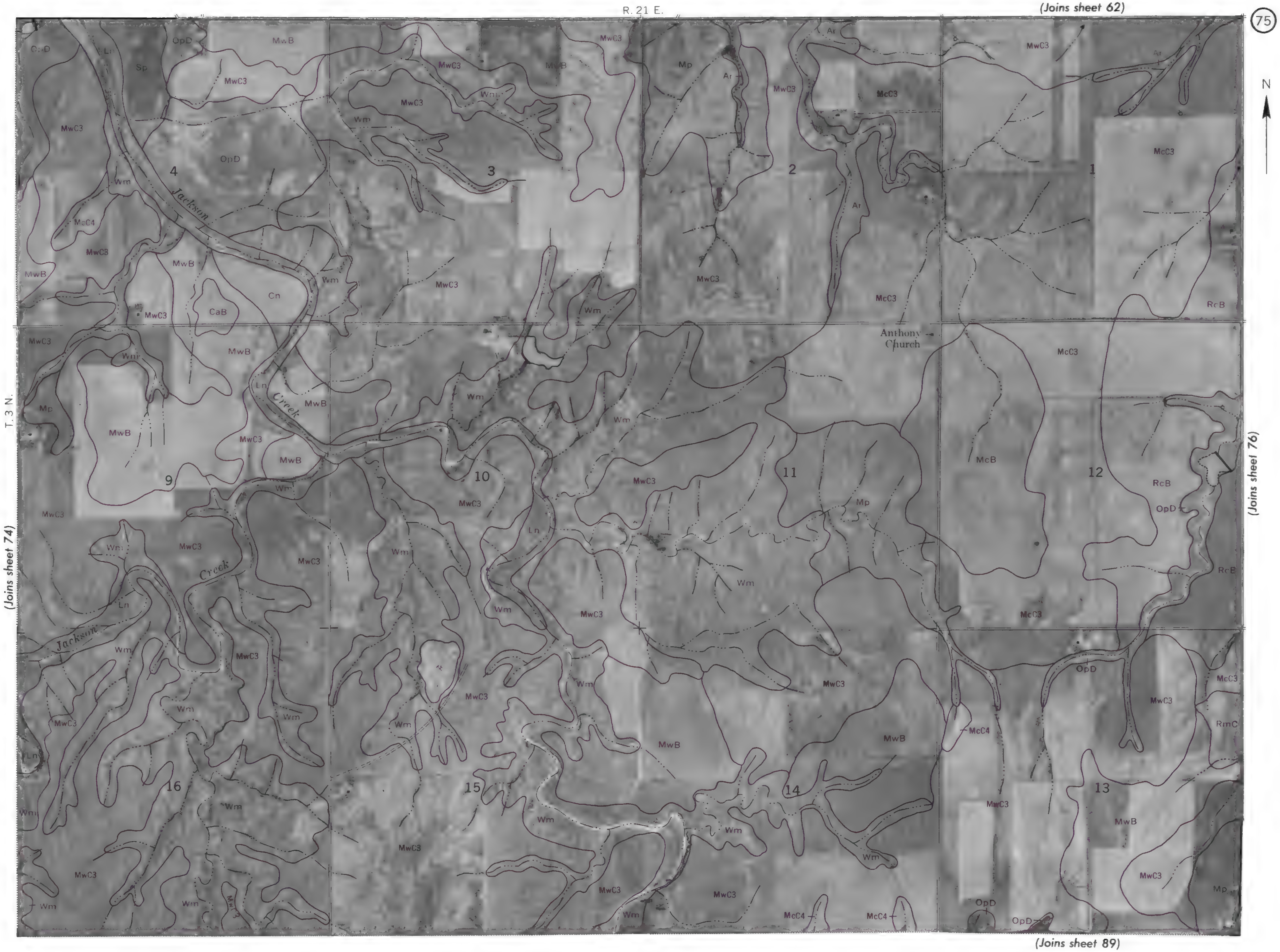
Range, township, and section corners shown on this map are indefinite.


74
(Joins sheet 61)
R. 20 E. R. 21 E.
N
(Joins sheet 73)
(Joins sheet 75)
T. 3 N.
(Joins sheet 88)
NORTH CANADIAN RIVER
Jackson Creek
1
2
5
6
7
8
11
12
13
14
17
18
0 ½ 1 Mile
Scale 1: 20 000
0 5000 Feet



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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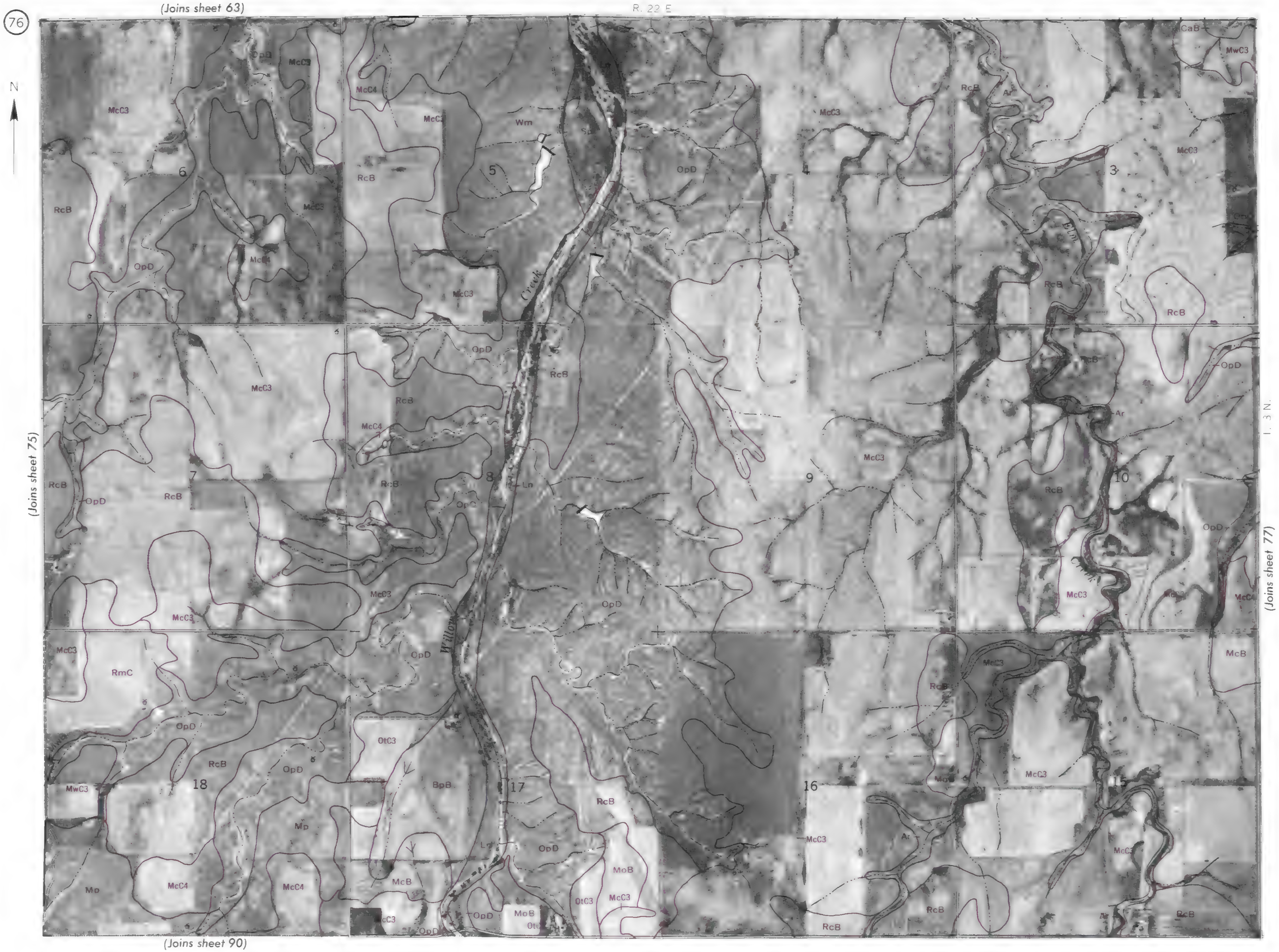
Range, township, and section corners shown on this map are indefinite.



Scale 1: 20 000

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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Range, township, and section corners shown on this map are indefinite

78

(Joins sheet 65)

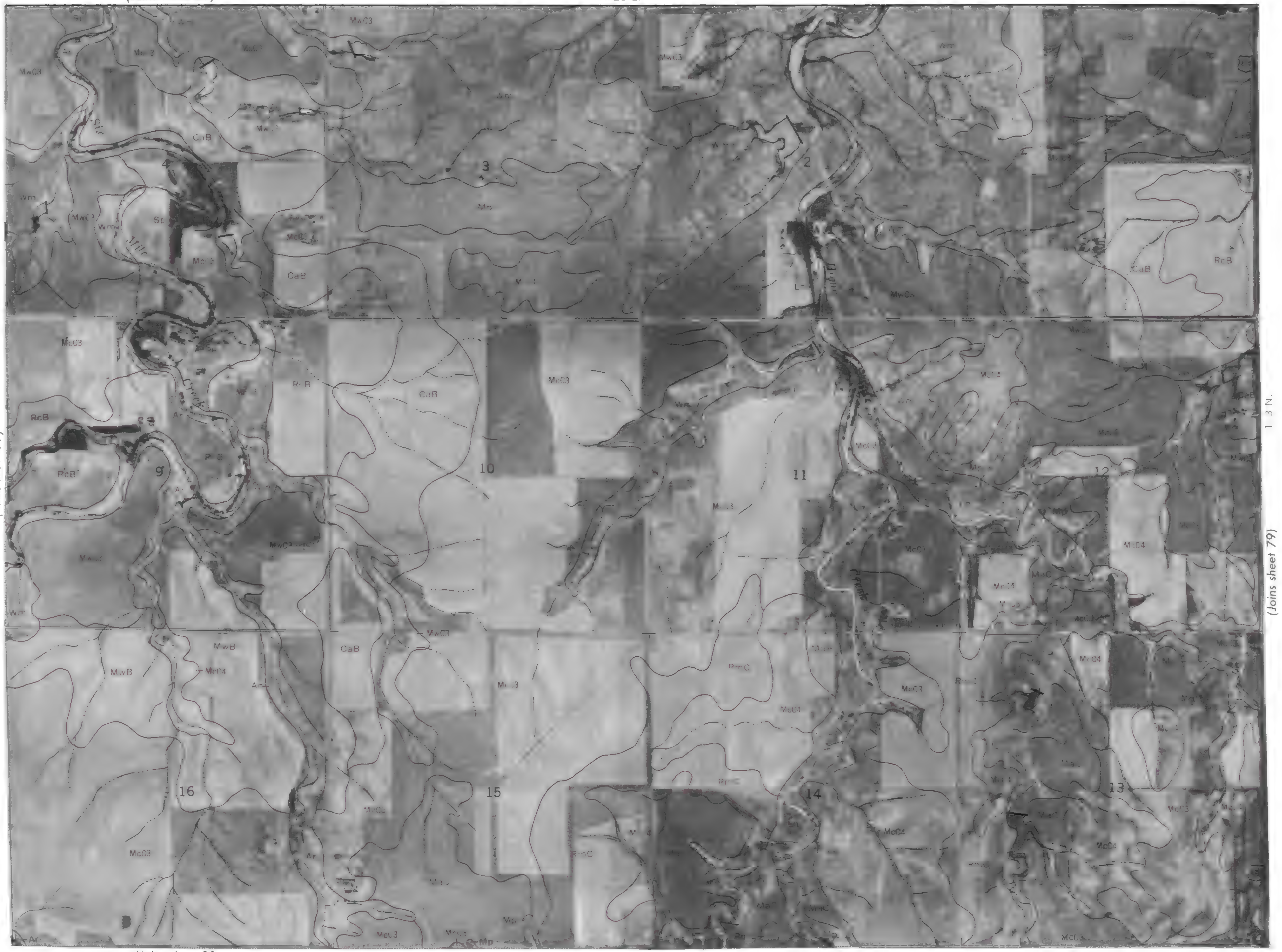
R. 23 E.

N

(Joins sheet 77)

T. 3 N.

(Joins sheet 79)



(Joins sheet 92)

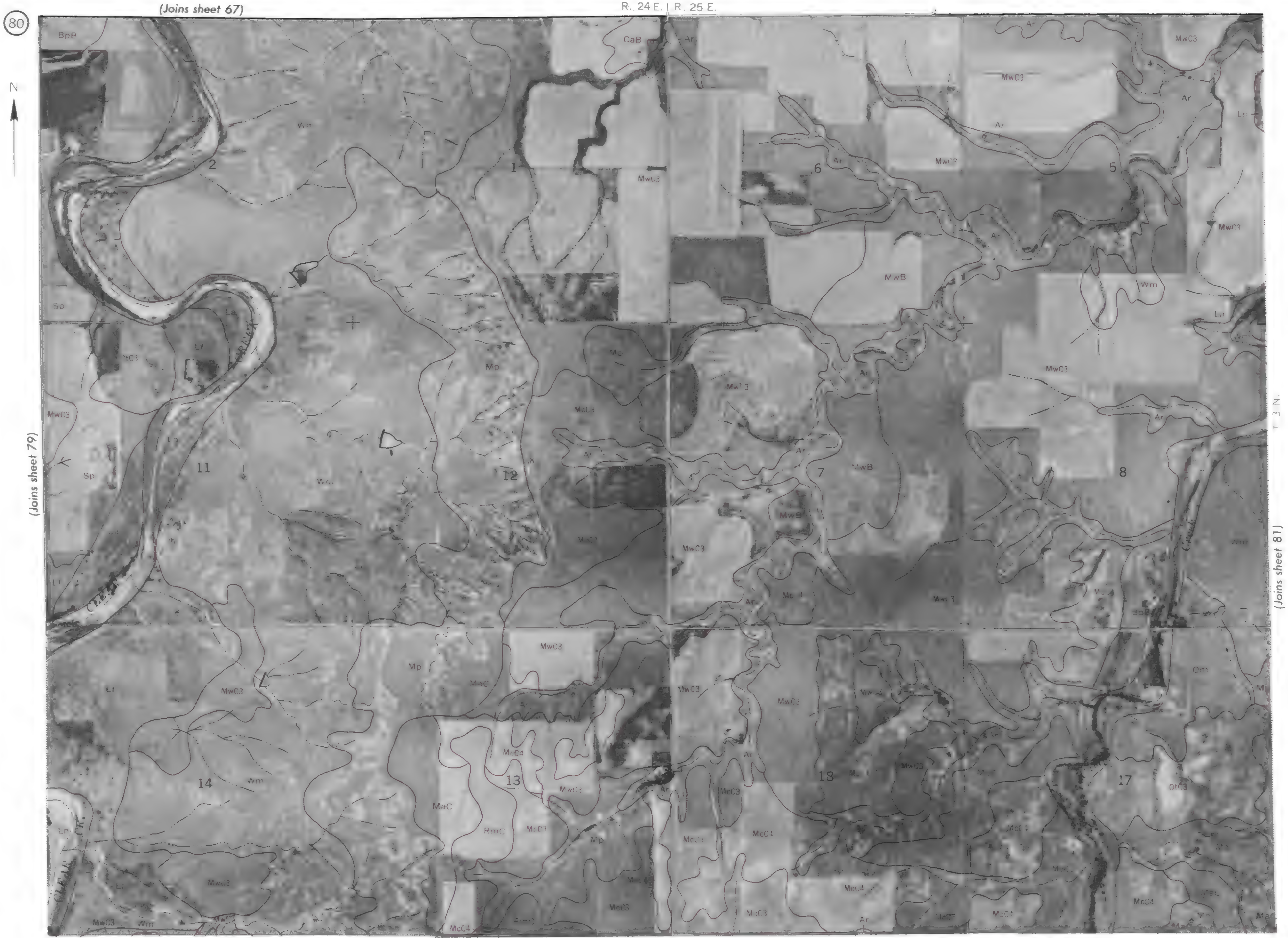
Scale 1: 20 000

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

(Joins sheet 67)



(Joins sheet 94)

0 ½ 1 Mile

Scale 1:20 000

R. 25 E.

(Joins sheet 68)

81

Scale 1: 20 000

0 ½ 1 Mile

0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.


82
(Joins sheet 69)
R. 26 E.
N
(Joins sheet 81)
(Joins sheet 83)
T. 3 N.
6
5
4
3
7
8
9
10
18
17
16
15
RmC
(Joins sheet 96)
1 Mile
Scale 1:20 000

R. 26 E. | R. 27 E.

(Joins sheet 70)

83

T. 3 N.

(Joins sheet 82)

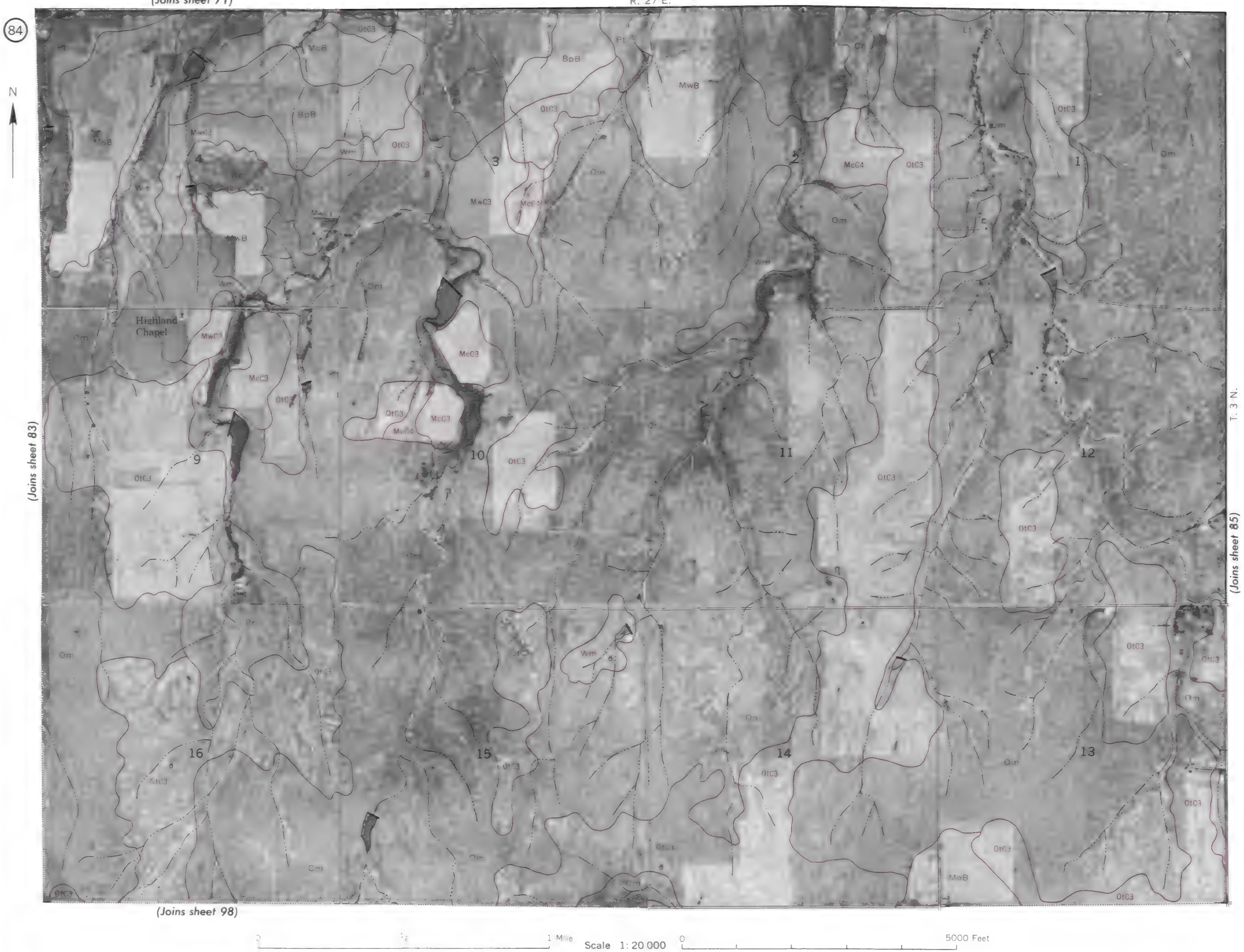
(Joins sheet 84)

(Joins sheet 97)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

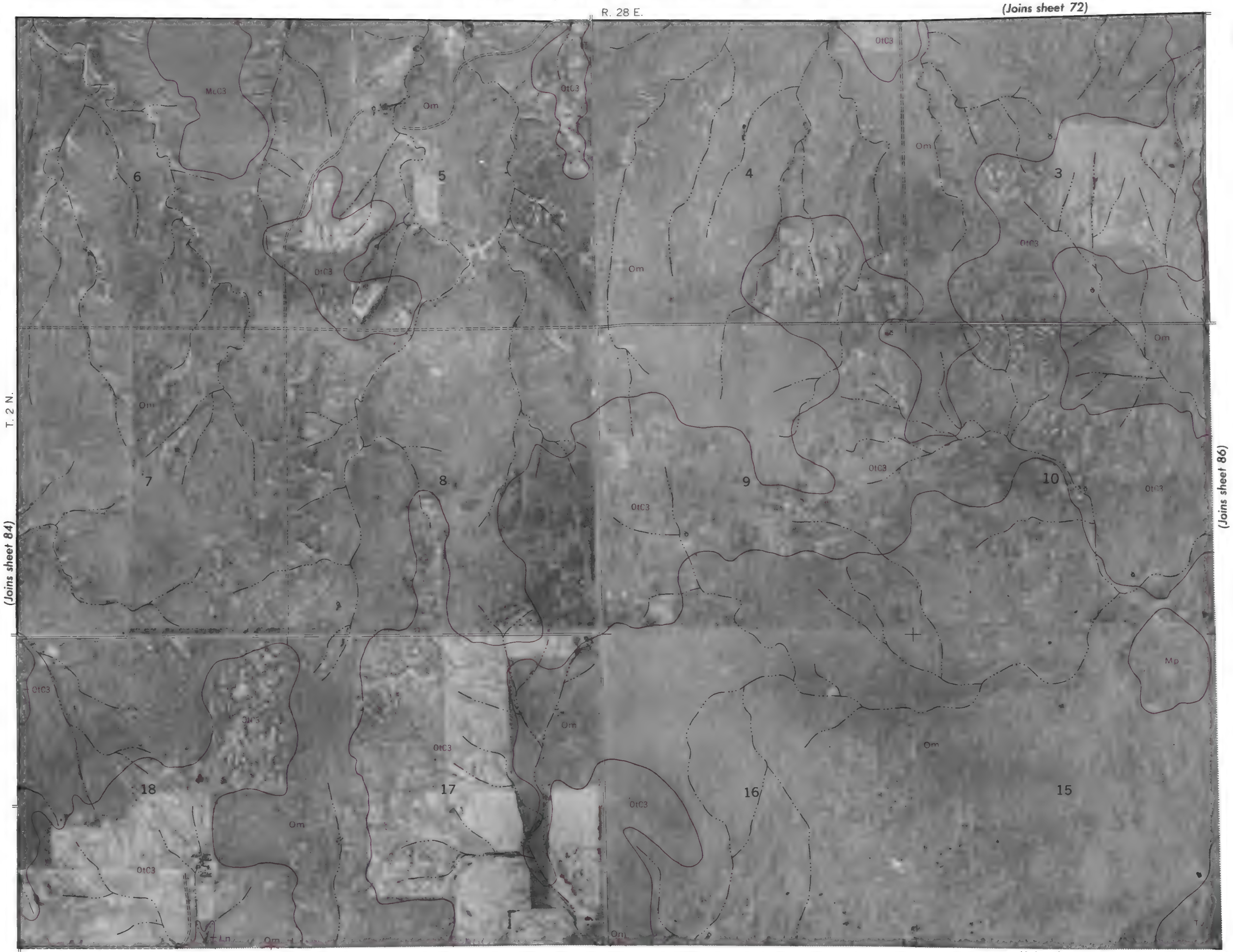

84
R. 27 E.
(Joins sheet 71)
(Joins sheet 83)
(Joins sheet 85)
(Joins sheet 98)
T. 3 N.
N
Highland Chapel
1
2
3
4
9
10
11
12
13
14
15
16
Scale 1:20 000
1 Mile
0
5000 Feet

R. 28 E.

(Joins sheet 72)

T. 2 N.

(Joins sheet 84)



(Joins sheet 86)

(Joins sheet 99)

N

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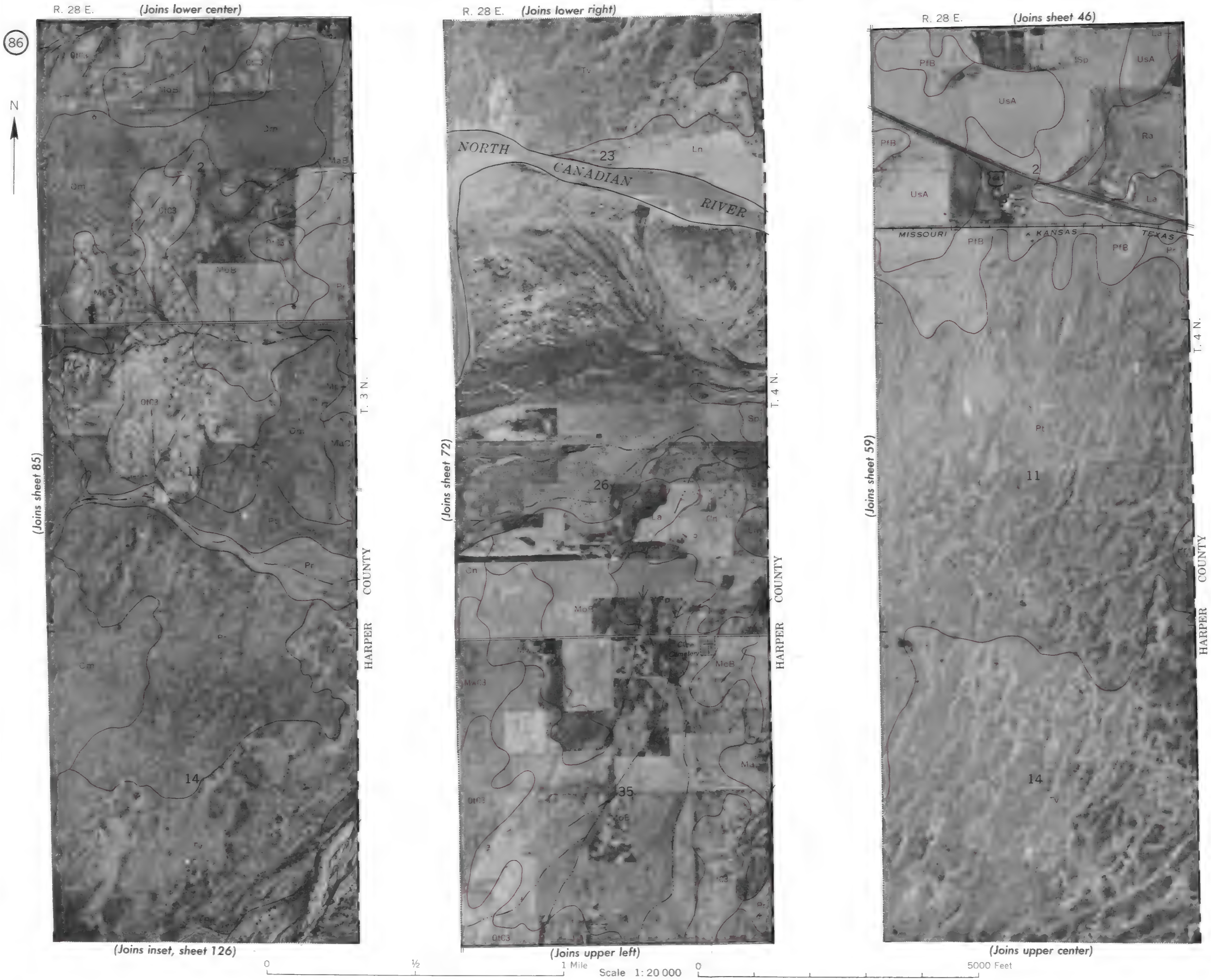
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 86



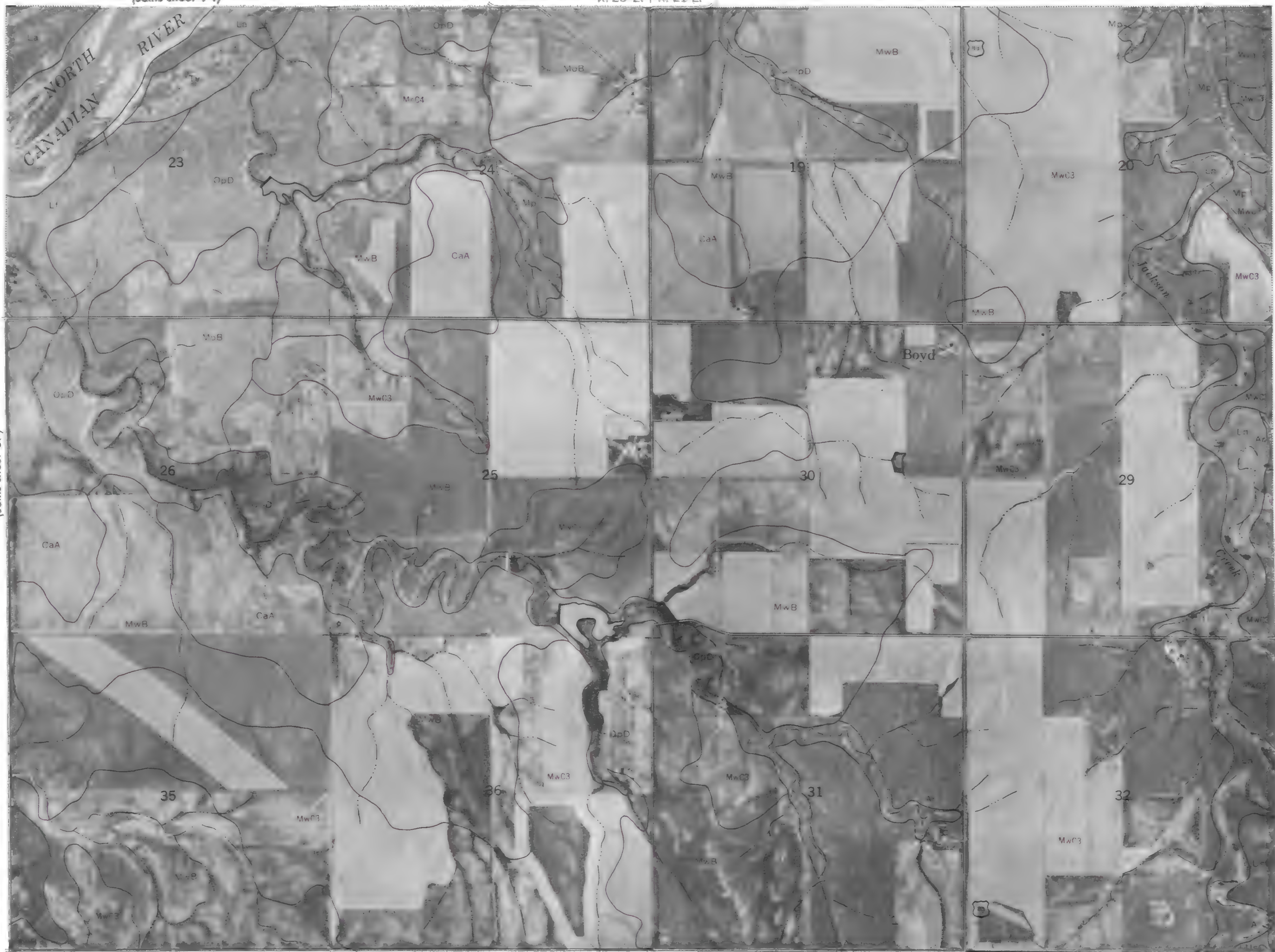
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

88

(Joins sheet 74)

R. 20 E. | R. 21 E.



(Joins sheet 87)

(Joins sheet 89)

(Joins sheet 101)

1 Mile Scale 1: 20 000 0 5000 Feet

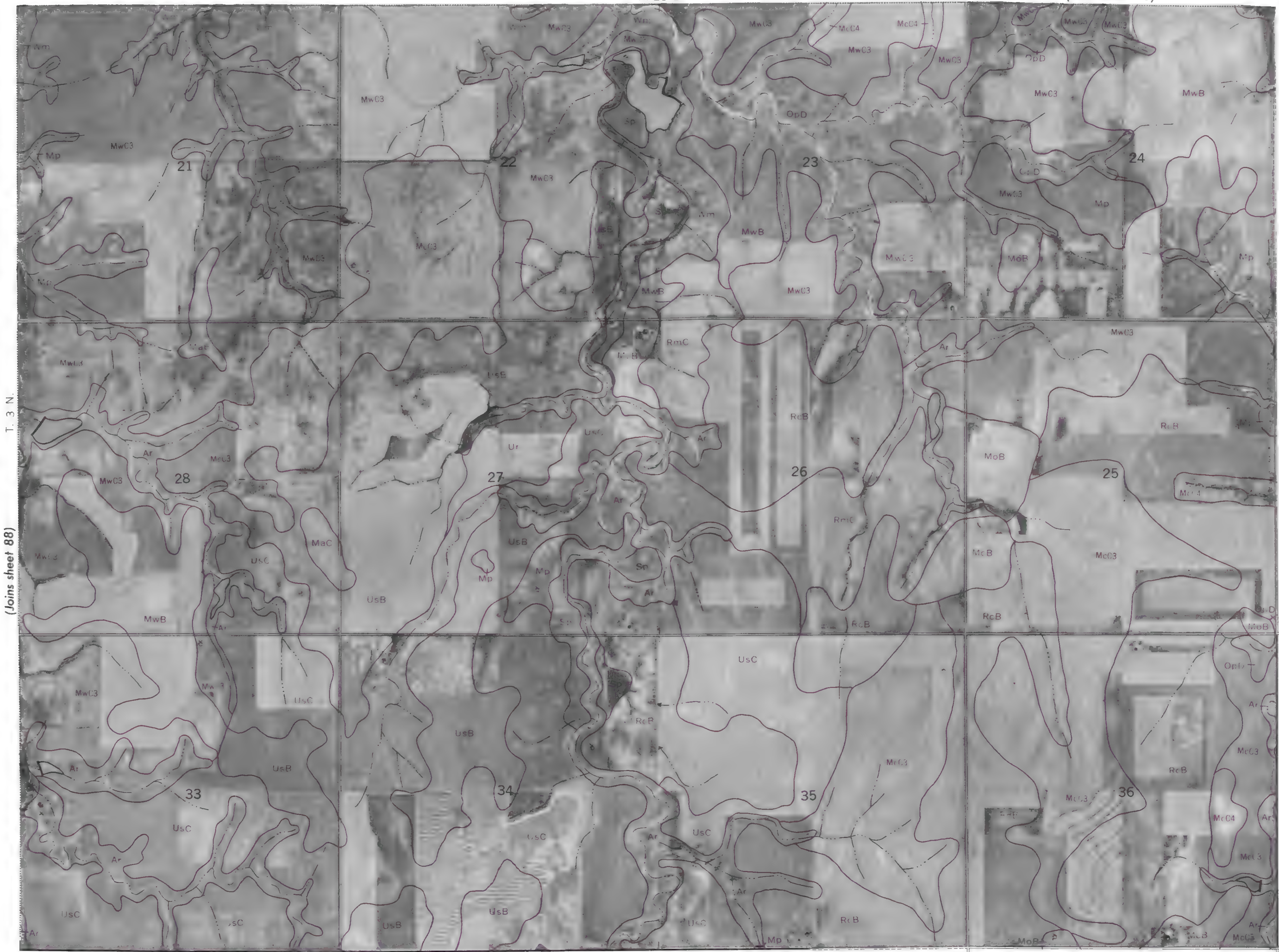
R. 21 E

(Joins sheet 75)

89

(Joins sheet 88)

T. 3 N.



(Joins sheet 90)

(Joins sheet 102)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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Range, township, and section corners shown on this map are indefinite.

90

(Joins sheet 76)

R. 22 E.

N

T. 3 N

(Joins sheet 89)

(Joins sheet 91)

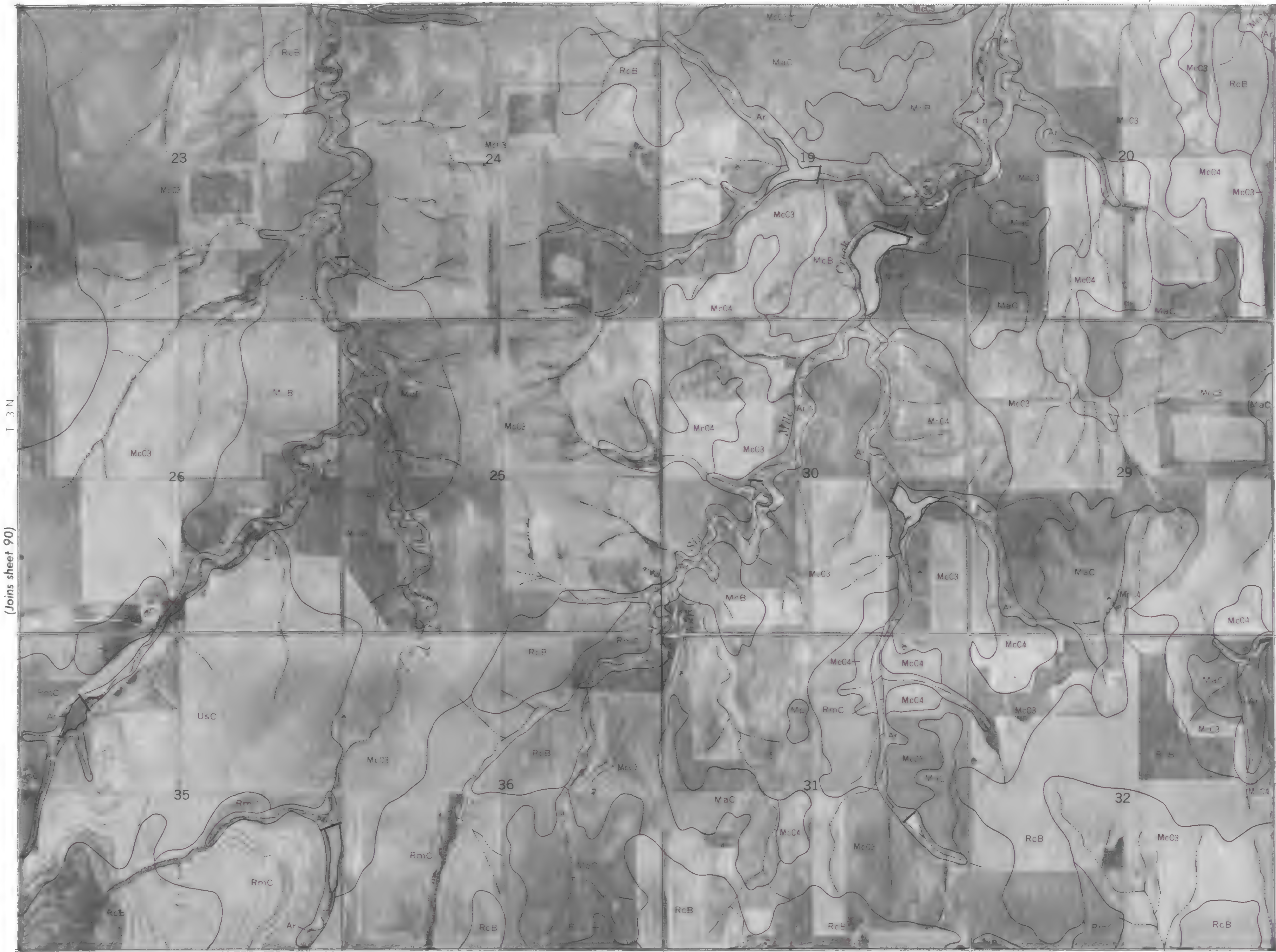
(Joins sheet 103)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

R. 22 E. | R. 23 E.

(Joins sheet 77)

91



(Joins sheet 90)

(Joins sheet 92)

(Joins sheet 104)

1 Mile Scale 1: 20 000 0 5000 Feet

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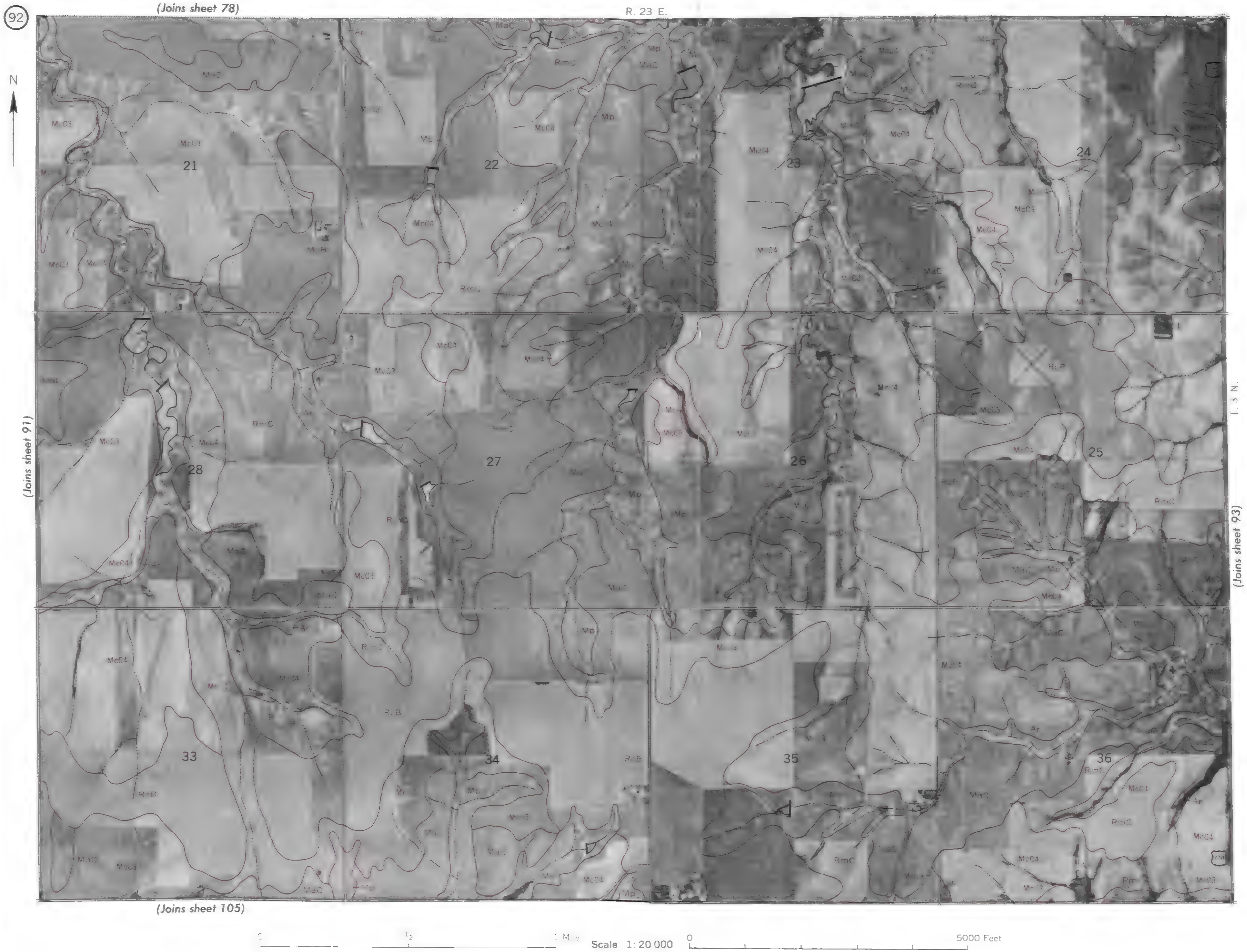
92
(Joins sheet 78)
R. 23 E.
N
21
22
23
24
28
27
26
25
T. 3 N.
(Joins sheet 91)
(Joins sheet 93)
33
34
35
36
(Joins sheet 105)
Scale 1: 20 000
0
5000 Feet

(93)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

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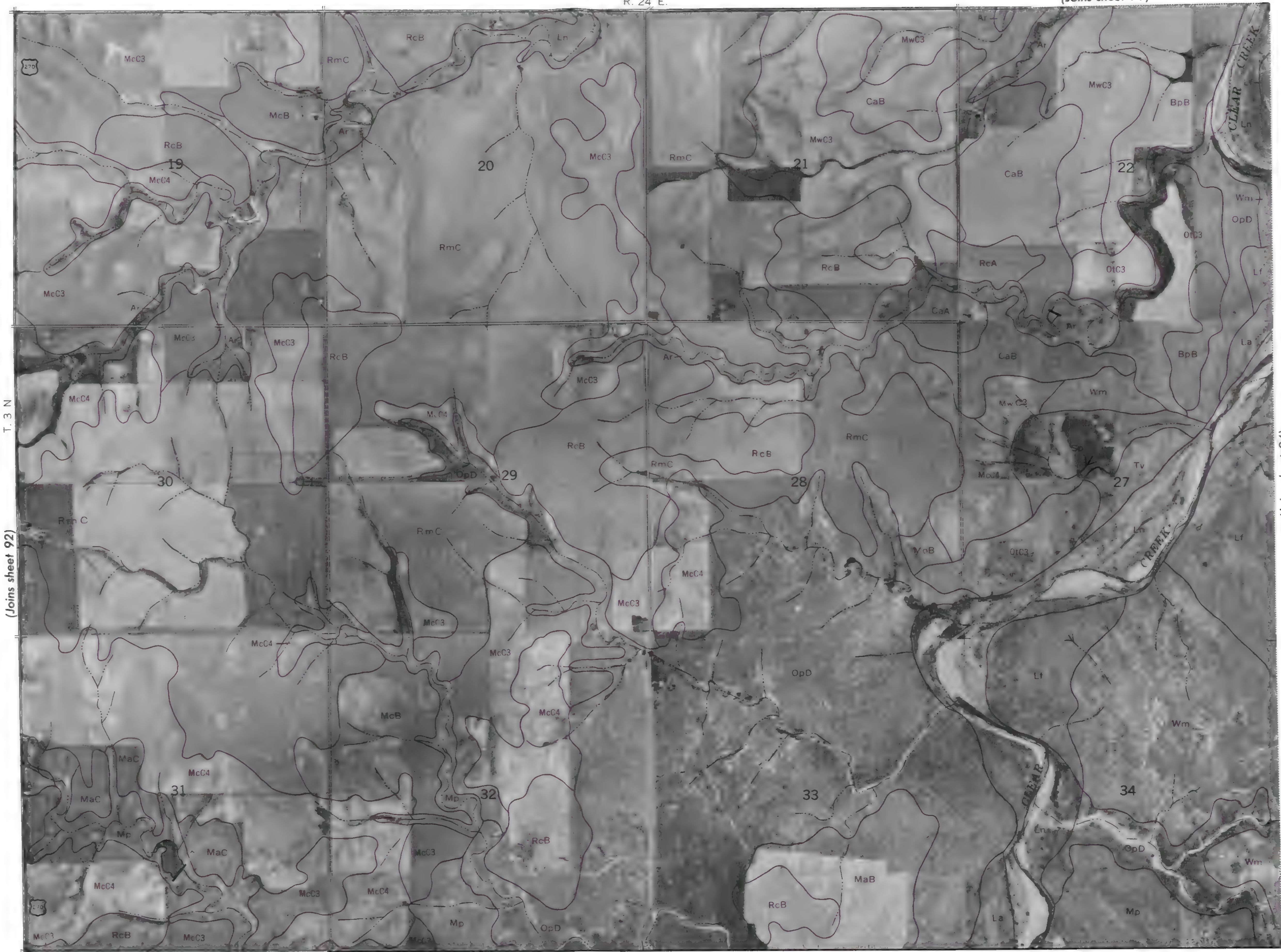


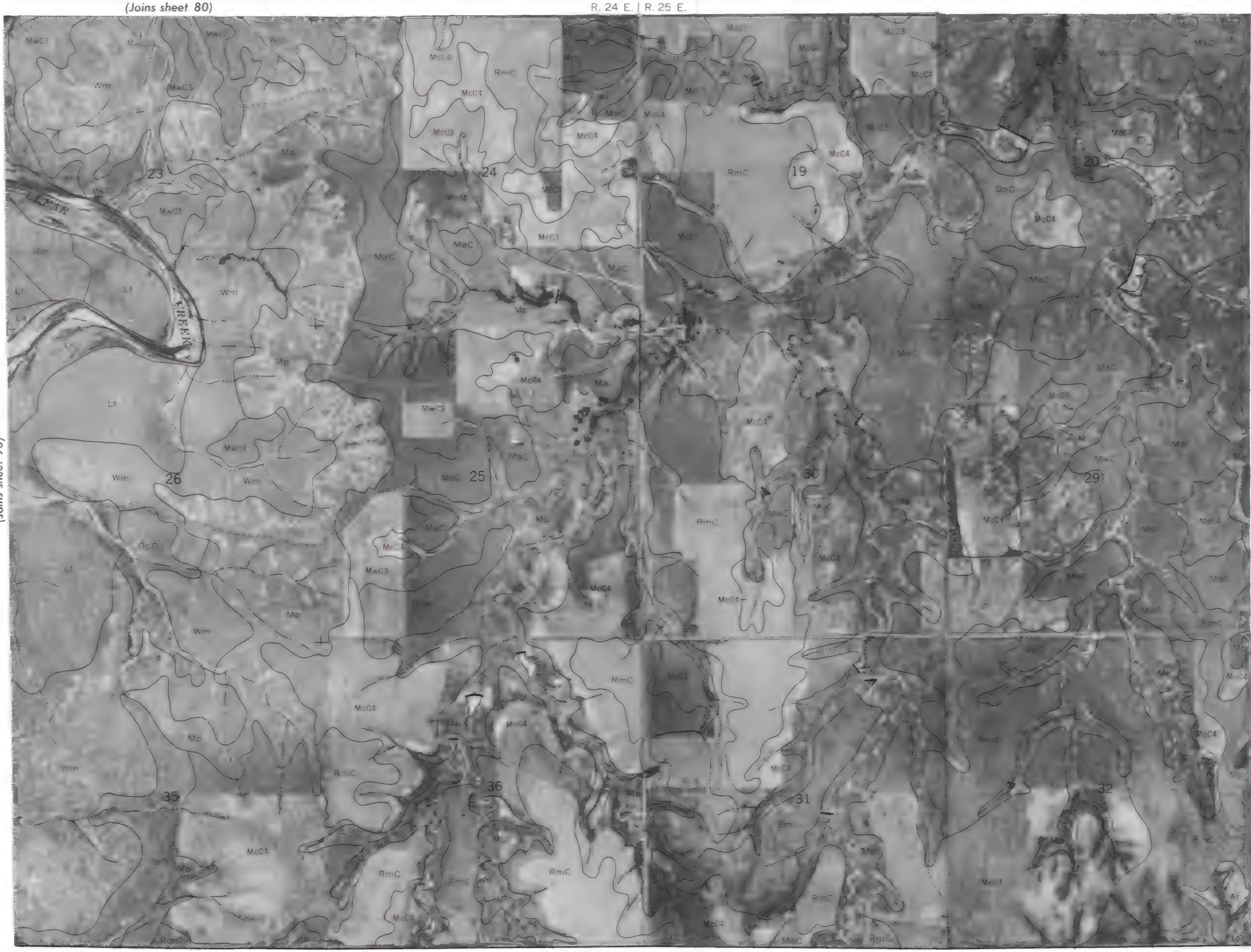
0 1/2 1 Mile Scale 1: 20 000 0 5000 Feet

94

(Joins sheet 80)

R. 24 E. | R. 25 E.

(Joins sheet 93)



T. 3 N.

(Joins sheet 95)

(Joins sheet 107)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 95

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

Range, township, and section corners shown on this map are indefinite.

96

(Joins sheet 82)

R. 26 E.

BEAVER COUNTY, OKLAHOMA — SHEET NUMBER 97

R. 26 E. | R. 27 E.

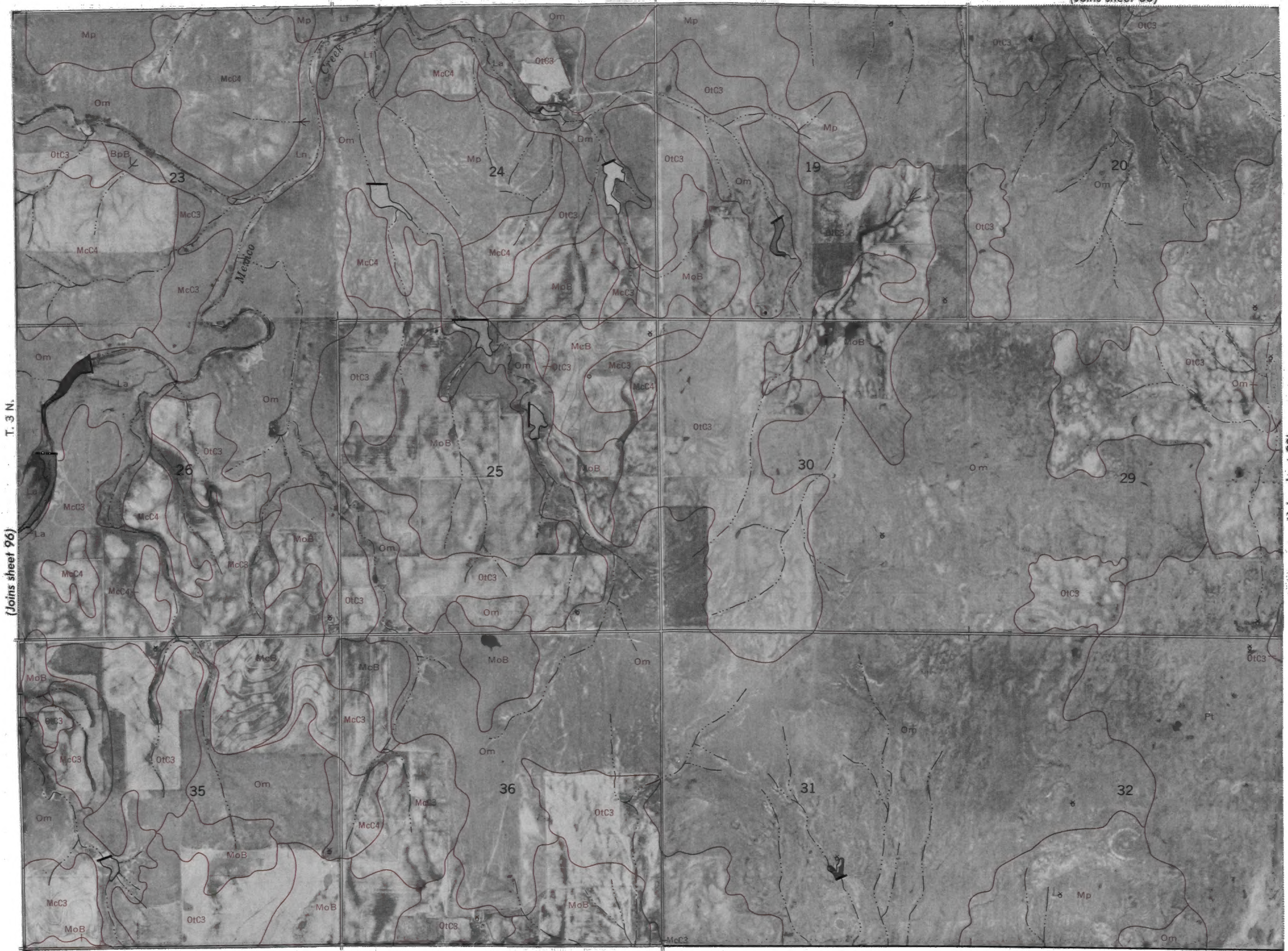
(Joins sheet 83)

97

N

T. 3 N.

(Joins sheet 96)



(Joins sheet 98)

(Joins sheet 110)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

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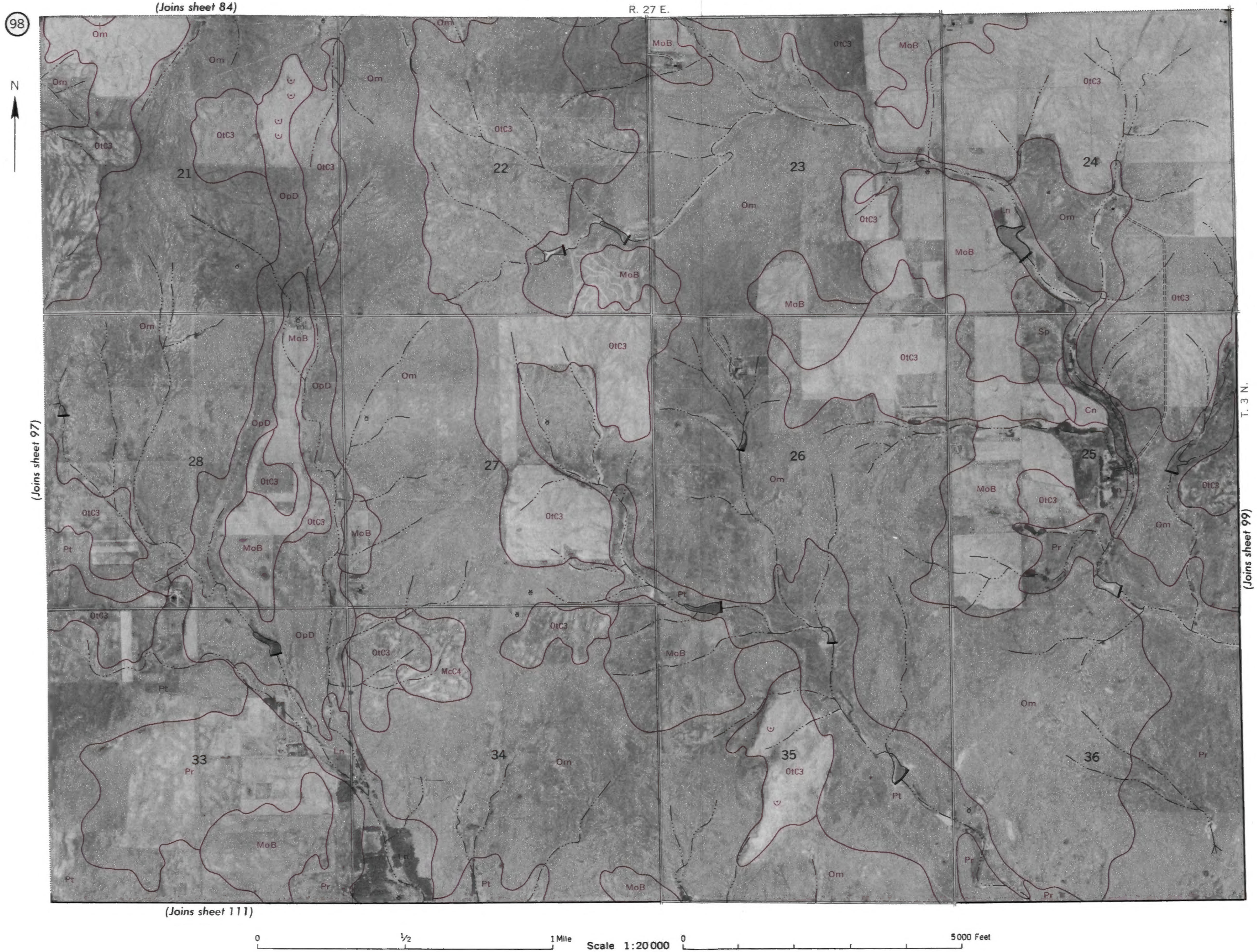
98
(Joins sheet 84)
R. 27 E.
N
(Joins sheet 97)
(Joins sheet 99)
T. 3 N.
(Joins sheet 111)
21
22
23
24
28
27
26
25
33
34
35
36
Om
OtC3
OpD
MoB
McC4
Ln
Sp
Cn
Pr
Pt
0
1/2
1 Mile
Scale 1:20 000
0
5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1953.

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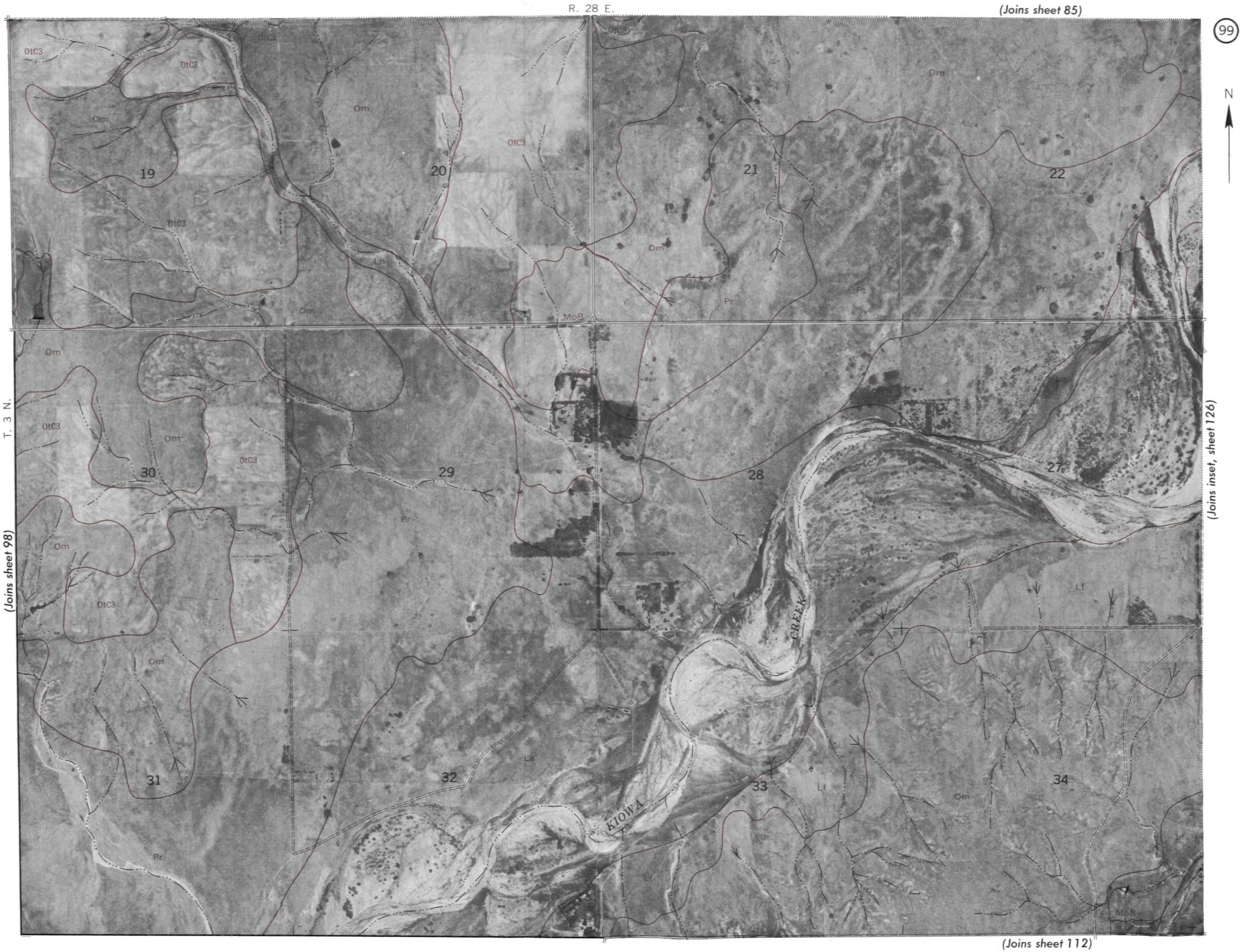

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet